AD NUMBER
ADB015344
LIMITATION CHANGES
TO: **Approved for public release; distribution is unlimited.**
FROM: **Distribution authorized to U.S. Gov't. agencies and their contractors; Administrative/Operational Use; APR 1976. Other requests shall be referred to Air Force Armament Laboratory, Eglin AFB, FL.**
AUTHORITY
usadtc ltr, 3 jul 1979

AFATL-TR-76-45, BOOK 2

Apr 76

AD-B015 344

HELP - A MULTIMATERIAL EULERIAN PROGRAM IN TWO SPACE DIMENSIONS AND TIME

SYSTEMS, SCIENCE AND SOFTWARE
P. O. BOX 1620
LA JOLLA, CALIFORNIA 92037

APRIL 1976

ud

FINAL REPORT: JULY 1974 - JUNE 1975

Cleared for Open Publication
ADTC/OI #1, 15 June 1979.

AIR FORCE ARMAMENT LABORATORY
AIR FORCE SYSTEMS COMMAND • UNITED STATES AIR FORCE
EGLIN AIR FORCE BASE, FLORIDA

CHAPTER X

GUIDE TO THE FORTRAN PROGRAM

The primary functions of each subroutine as well as the definitions of important variables are given in the following sections. The flags and conventions which are unique to the HELP code are also listed and discussed.

10.1 A GENERAL FLOW DIAGRAM

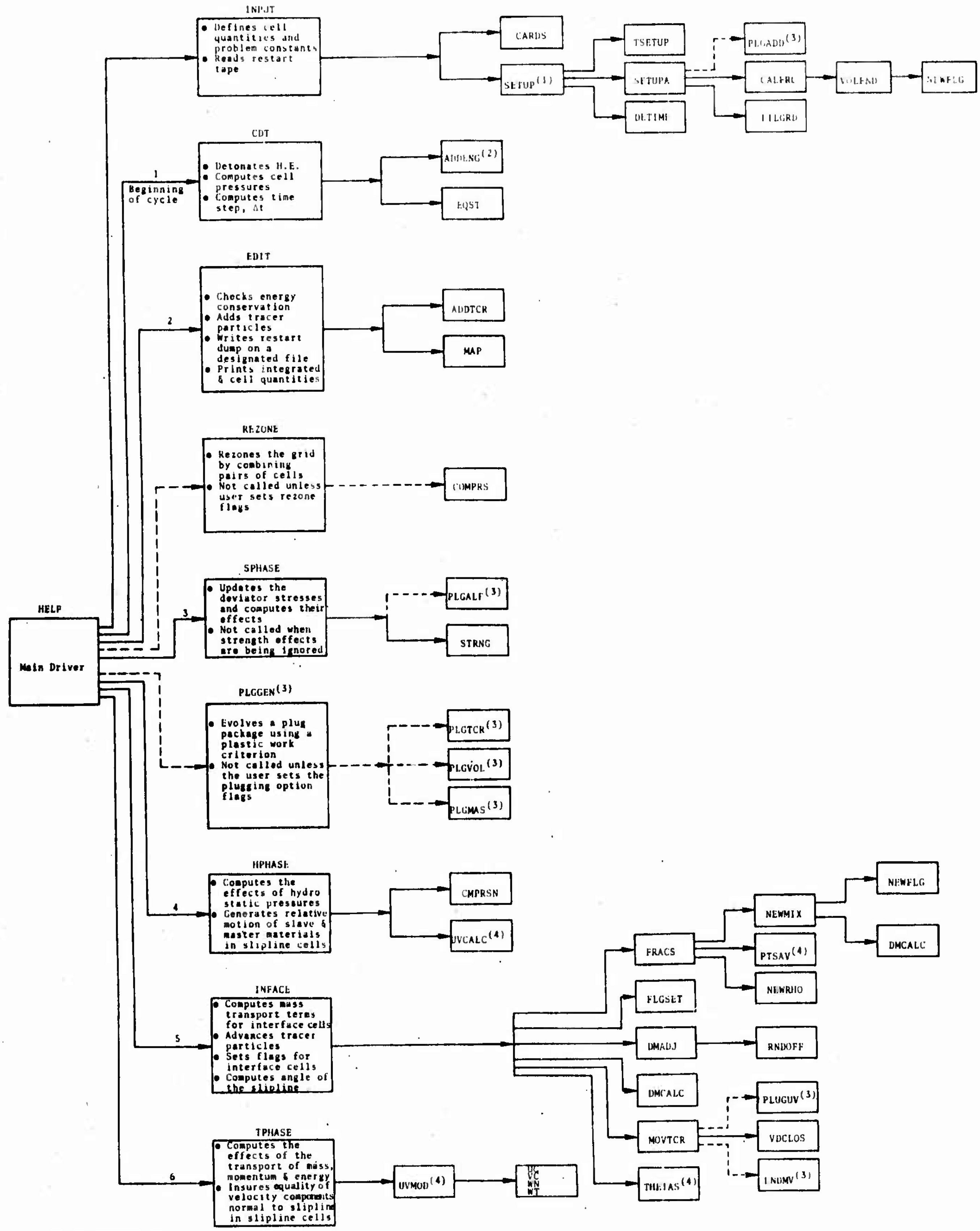
The flow diagram given in Figure 10.1 indicates the organization of the code and describes the functions of the primary subroutines which are called from the main driver routine. The subroutines which in turn are called by each of the primary subroutines are also indicated. The calculational cycle has six stages: (1) the calculation of the cell pressures and the time step (CDT); (2) the periodic editing of cell quantities and checking for energy conservation (EDIT); (3) the calculation of the effects of deviator stresses (SPHASE); (4) the calculation of mass transport terms for interface cells (INFACE); and (6) the calculation of the effects of transport (TPHASE). For calculations which ignore the strength effects, the third stage is skipped. For calculations in which a plug is generated, another stage (PLGGEN), following SPHASE, is added to the cycle. The rezone, if used, is invoked following the EDIT stage.

10.2 DESCRIPTION OF THE SUBROUTINES

The primary functions of each HELP subroutine are described below. The subroutines are listed alphabetically.

ADDENG

ADDENG is called only if one of the material packages is a high explosive. ADDENG examines the detonation time associated



1) Called only when generating problem on cycle 0.
2) Called only when detonating a high explosive.
3) Called only when using the plugging model.
4) Called only when using sliplines

Figure 10.1--General flow diagram of the HELP code.

with each cell containing undetonated high explosives to ascertain if it is time for it to be detonated. Once it is determined that cell k is to be detonated, DETIM(k) is set to 0, which allows the cell to become active, and the energy of detonation is added to the cell and system. The DETIM array used by ADDENG is computed in DETIME when the problem is generated. After all cells containing high explosives have been detonated, ADDENG is no longer called.

<u>ADDTCR</u>

Material tracers can be added in a specified region at any point in the calculation by defining input flags (NADD, NTRACR, MINX, MINY, MAXX, MAXY). When NADD > 0, ADDTCR is called from EDIT every cycle which is a multiple of NADD. ADDTCR adds new tracers between existing pairs of tracers in the region defined by MINX, MINY, MAXX, MAXY but does not create a greater density of tracers than that specified by NTRACR. (See Section 8.2.)

<u>CALFRC</u>

CALFRC is part of the problem generator and is called only in the initial setup of a problem. Subroutine CALFRC follows each tracer string through the grid and, for each cell intersected by it, determines which side of the cell the string enters (storing this information in the variable KODENT) and through which side the string leaves (storing this information in the variable KODLEV). The X and Y centimeter coordinates of the entry point on the cell boundary are stored in the first location of the arrays XT and YT, respectively. The centimeter coordinates of all successive tracer particles which lie inside the cell are stored in succeeding locations in the XT and YT arrays. When CALFRC determines the string has left the cell, the centimeter coordinates of the exit point are determined and stored in the next available location of the XT and YT arrays. There can be no more than 50 tracer particles which define the position of the material

interface in the mixed cell. CALFRC defines two other variables, NTST and NTND, which specify the initial and final material tracer particle numbers, respectively, which lie in the cell. These numbers are used in VOLFND to determine if the slipline lies in the cell.

CARDS

The input parameters stored in the Z-block of blank common are read by subroutine CARDS. The format of these input cards is described in Section 7.2.1.

CDT

A principal function of this routine is to compute a time step which ensures stability of the finite difference equations. This is done by finding the cell with the minimum ration, D/ω. Here D denotes the minimum of the cell's dimensions (cm) and ω denotes the sum of the cell's maximum velocity component and its sound speed (cm/sec). For an ideal gas the sound speed is computed as $\sqrt{\gamma P/\rho}$ and for other materials by the approximate relation $C = C_o + \bar{B}\sqrt{P}$ where P is the pressure in the cell. The coefficient $\bar{B}$ is an input parameter and is described more fully in Section 10.3 (See BBAR). C_o is defined as $\sqrt{A/\rho_o}$, where A is the bulk modulus of the material. The values of C_o for nineteen materials are given in a DATA statement in the "included" element, COMDIM. In a multimaterial cell the sound speed is given by a mass weighted average of the sound speeds of the materials in the cell. Each cycle CDT prints the column and row (I,J) of the cell controlling the time step as well as the maximum sum of sound speed and velocity for any cell in the grid (MAXCUV), the maximum velocity for any cell in the grid (MAXUV), and the velocity and pressure cutoff values (UMIN,PMIN).

Another function of CDT is to equilibrate the pressures of materials in mixed cells by using an iteration scheme that adjusts the material densities. A detailed discussion of this iteration method is found in Section 4.6.1. The pressures for

pure cells are also updated in CDT by a call to the equation of state subroutine, EQST. The density, specific internal energy and material code number of the cell (RHOW, ENERGY, N) are passed through blank common.

When a high explosive is being detonated, CDT calls ADDENG to release energy in cells containing H.E. according to the detonation time (DETIM) associated with each cell.

CMPRSN

CMPRSN computes an average compression (ρ/ρ_0) of the material(s) in a cell. These compressions are used as weighting factors by HPHASE in the definition of cell boundary pressures and velocities when at least one of the cells contains the free surface or when the ratio of the average compressions of the two cells is large (> CRATIO). (See Section 2.2.2.4.)

COMDIM

COMDIM is not a subroutine, but is an element which is inserted in place of the statement "INCLUDE COMDIM" in most of the HELP subroutines. (This terminology is unique to UNIVAC computers, but the feature is offered by most large computer systems.)

This included element in HELP contains dimension, common and equivalence statements and two data statements which define material constants, ρ_0 and C_0, for various solids and high explosives.

COMPRS

COMPRS is called by subroutine REZONE to create a new cell by combining two adjacent cells into one, the velocity and energy of the new cell being defined so that energy and momentum are conserved. If both cells are pure, then the new cell will also be pure. If one or both contain an interface, the new cell will be an interface cell. (See Section 8.1.)

DETIME

DETIME defines the detonation time array, DETIM, used in ADDENG. DETIME accomplishes this by computing the time required to traverse a line from an initiation point to the center of a cell, plus any delay time associated with the initiation point. All cells in the path must contain explosives, as any non-explosive cell in the path is treated as an obstacle and will prevent detonation of the cell by the initiation point. The X- and Y-coordinates, delay time (used by primary initiation points only), and material package number are read in for each primary and secondary initiation point. (Secondary initiation points are defined as initiation sites which are detonated by a primary initiation point.) After all initiation points are read in, the X- and Y-coordinates which describe the probable area of detonation (the area to be searched) corresponding to each of the primary and secondary initiation points are read in. The detonation time is computed for all explosive cells within the specified area to which there is an unobstructed path from the initiation point. See Section 2.3.4.1. The input cards are described in Section 7.2.7 and in Appendix B.

DMADJ

DMADJ adjusts the mass transport terms of interface cells. On the first subcycle of INFACE, DMADJ is called to define the mass transport terms of a material which must be evacuated from a cell because its interface has left the cell. The outflux terms are adjusted (in proportion to the outflux terms calculated on the previous cycle) so as to exactly equal the mass remaining in the cell. The influx terms are set to zero.

After all INFACE subcycles are completed, DMADJ is called again to check that the computed transport terms will not result in a negative mass. Also, if INFACE is being subcycled (CYCMX > 1), the evacuation procedure described above is repeated since an interface could have left a cell on a subsequent subcycle. (See Section 4.4.)

DMCALC

DMCALC computes the transport terms for each material across the four boundaries of each interface cell. DMCALC uses the fractional cell face areas (computed by subroutine FRACS) associated with each material package in the problem. In this way the position of the material interfaces in the cell is taken into account. The transport terms for the top, right, bottom and left boundaries of the interface cells are stored by DMCALC in the SAMPY, SAMMP, SAMMY, and SGAMC arrays, respectively. TPHASE performs the actual transport of mass, momentum and energy for both interface and pure cells.

EDIT

The periodic printing and writing on the restart tape are executed by subroutine EDIT. The frequency of printing and tape dumps is controlled by input parameters described in Section 7.2.1.

On every print cycle EDIT prints the mass, total energy, internal energy, kinetic energy, axial and radial momentum, and plastic work for each material package as well as for the entire grid. The changes in energy due to "evaporation" and to mass lost across grid boundaries are also accounted for. The coordinates of the material tracers circumscribing each package are printed in cell units. Summary graphs of the compression (or density), pressure, radial velocity, axial velocity and internal energy are printed if the input parameter, MAPS, is non-zero. And finally, the pressure, radial velocity, axial velocity, internal energy, mass, compression (or density) and stress deviators for all cells in the active grid are displayed on "long" EDIT prints and for only the cells in the axis column on "short" EDIT prints.

EDIT periodically calls ADDTCR to add tracer particles if the input parameter NADD is non-zero. (See Section 8.2.)

Another important function of EDIT is to check the relative error between the sum of the total energy of all the cells, and ETH, the theoretical energy of the grid. If this error exceeds a limit specified by the input variable DMIN, EDIT calls ERROR and the code performs an error exit.

EDIT also determines when execution should stop and sets the exit flag, WFLAGL.

ENCHCK

ENCHCK is called by the main routine, HELP, after each phase of the cycle to compute the relative error between the total grid energy and ETH. The energy of the cells is summed and compared to the theoretical energy, ETH, which is the energy at time T = 0 plus any energy added to the grid (e.g. when an explosive is being detonated), minus any energy subtracted from the grid (e.g., when material is "evaporated" or transported out of the grid). ENCHCK prints the name of the phase (TPHASE, SPHASE, HPHASE) which has just been completed, along with ETH, the energy sums and the relative error. Two energy sums are computed, one using material velocities (EMIX) and one using cell velocities (ESUM). The relative error is based on the EMIX sum.

These prints can be used to track down errors which result in energy not being conserved by noting if there are consistent, large increases in the relative error each cycle following the execution of one of the phases.

ENDMV

ENDMV is called only when the plugging model is being used. After the plug is completely formed, all the tracers on the vertical edge of the plug are moved with projectile and plug velocities except the tracer at the top, which is moved with target velocities only. The larger axial velocities in the plug will cause the tracers below the top point on this plug surface to eventually be moved above the top point by MOVTCR. Subroutine ENDMV relocates

these tracers at the position of the top point, thereby accumulating tracers at that point as the plug moves beyond the back surface of the target.

EOUT

EOUT keeps track of the changes in kinetic and internal energy of each material package due to changes in the theoretical grid energy, ETH. EOUT is called from HPHASE, TPHASE, and SPHASE.

EQST

Given a material code number as well as a density and specific internal energy, EQST computes a pressure. The equations of state used by EQST are discussed in Section 2.3.1. The material constants defined in DATA statements in EQST are listed in Tables 2.1 and 2.2. CDT calls EQST when computing the pressure of pure cells as well as when iterating to equilibrate material pressures in multimaterial cells.

ERROR

This subroutine is called in case certain error conditions are sensed by the code. ERROR prints a message identifying the general location within the subroutine which detected the error condition (see error message #6 in Section 9.1). It lists the Z-block variables (the first 150 words of blank common), and calls EDIT to do a long print and a tape dump, and then stops execution.

FILGRD

FILGRD is part of the problem generator and is executed only during the initial setup of the problem. FILGRD determines the MFLAG values of all pure cells in the grid except for the one in the lower left corner, which the user defines. Given the initial density, velocity components and internal energy of each material package, FILGRD defines the mass,

velocity components and specific internal energy of each cell in the grid. The mass of a pure cell is based on the cell's MFLAG value which indicates which package the cell belongs to. If the cell is an interface cell, the mass of each material in the cell is computed by FILGRD using the partial volumes computed by VOLFND.

FLGSET

FLGSET is called on each subcycle of INFACE, after the fractional cell face area terms are computed. Based on the updated area terms, FLGSET determines which (if any) interface cells have become pure (lost all interfaces), and which (if any) have lost some, but not all, interfaces. In either case one or more materials must be evacuated from the cell. FLGSET implements the following conventions to denote the occurrence of these events: (1) the density RHO(n,m) of any material(s) to be evacuated is set to zero; (2) the MFLAG of any interface cell that has become pure is made negative. However, any cell that has become pure is still handled as an interface cell until the end of the cycle, when its MFLAG is changed in TPHASE.

FLGSET also checks that the sum of the fractional cell face areas for each interface cell boundary equals the total area of that boundary. If the sum differs from the total area by more than 1% an error message is printed (see error message #30 in Section 9.1). The error is usually the result of interfaces crossing because the tracer particles have become too sparse.

FRACS

The straight line segments which connect the tracer particles that circumscribe each material package are used by FRACS to determine where the interfaces cut cell boundaries and to compute the fractional cell face areas. Section 4.3 gives a detailed description of the logic and conventions employed by FRACS.

HELP

The overall cycling of the calculation is controlled by HELP, as shown in Figure 10.1. HELP is the main routine of the code and calls INPUT, CDT, EDIT, REZONE (if it is a rezone cycle), SPHASE, PLGGEN (if the plugging option is used), HPHASE, INFACE and TPHASE in that order. When the user desires to see the effects of each phase of the calculational cycle, HELP will respond to the input parameter INTER and, on print cycles, call EDIT after SPHASE and HPHASE as well as after CDT (see Section 9.2). HELP also calls EXIT on the normal cessation of the calculation when WFLAGL > 0.

HPHASE

The effect of the pressure gradients in updating the velocities and the internal energies is computed in HPHASE. (The numerical method is described in detail in Section 2.2.2.)

INFACE

INFACE controls the subcycling of FRACS, FLGSET, DMADJ, DMCALC, and MOVTCR. the subroutines which compute the mass transport terms of interface cells and which advance the tracer particles. If sliplines are used (NOSLIP = 0) INFACE calls THETAS, after the subcycles are completed, to compute the angle of the slipline across each slipline cell.

INPUT

Instructions for running problems are interpreted by subroutine INPUT, which can either start or restart a calculation. It calls CARDS to read the first part of the input deck, and, on cycle 0, calls SETUP to generate the initial conditions of the calculation. When generating a calculation, INPUT rewinds and reads the restart file after SETUP writes the cycle 0 dump, and, when restarting a calculation, INPUT finds and reads the restart dump.

MAP

This subroutine is called by EDIT when the input parameter MAPS is non-zero. It displays the properties of each cell in the active grid using an alphabetic scale. The user obtains symbolic maps of the compression, pressure, radial and axial

velocities, and specific internal energy by setting MAPS = 1. To get a density map instead of a compression map, the user sets MAPS = 2. Asterisks are displayed for the interface cells in the density and compression maps. The scale of each map is adjusted according to the current minimum and maximum values of each quantity.

<u>MOVTCR</u>

The material and passive tracer particles are moved with a local velocity field in MOVTCR. A description of the method for moving tracers is given in Section 4.1.2.

<u>NEWFLG</u>

NEWFLG determines the MFLAG value of new interface cells (see Section 4.2.1).

<u>NEWMIX</u>

NEWMIX is called from FRACS to define variables for a new interface cell. If a cell becomes an interface cell after the first subcycle of INFACE, NEWMIX calls DMCALC to make the definition of the mass transport terms for that cell consistent with the number of subcycles already completed. (See Sections 4.2.2 and 4.2.3.)

<u>NEWRHO</u>

When the material n interface first enters a cell, INFACE calls subroutine NEWRHO to define the density of material n for that cell by looking at the density of material n in the neighboring cells closest to the interface. (See Section 4.2.2.)

<u>PLGADD</u>

PLGADD is called by SETUP only when the plugging model is being used. It adds target and plug material tracer particles at the corner where the plug surface will begin. Those additional points will be used to define the vertical edge of the plug as it evolves. This edge will be a slipline and the plug will be package 2 and a "slave", so the number of tracers

added at the corner is defined by the plug slipline end-points, NBGSD(2) and NENDSD(2), which in turn are defined by the user in the INPUT deck. (See Section 6.1.)

PLGALF

PLGALF computes the angle of maximum shearing stress for cells in the plugging region of the target, given their deviator strain rates. PLGALF is called from SPHASE only if the plugging model is being used.

PLGGEN

At the end of SPHASE, when the plugging model is activated, PLGGEN is called to update the specific plastic work of the material associated with each passive tracer in the plugging region of the target. If the criterion for extending the plug surface is satisfied, PLGTCR, PLGVOL and PLGMAS are called to enlarge the plug package. (See Section 6.2.1.)

PLGMAS

PLGMAS converts target material (package 3) into plug material (package 2) by redefining the RHO, SIE, and XMASS arrays. PLGMAS also updates the plug and slipline endpoints (SLPNDX, SLPNDY). (See Section 6.2.4.)

PLGTCR

When the slipline is advanced, PLGTCR moves the tracers at the top of the plug package into the row containing the new end point of the slipline. When the last row of the target fails, the tracers at the top of the plug are made coincident with the target tracers out to the point at which the slipline intercepts the top of the target. Two plug tracers are left at that intercept point. One moves out with the plug, the other remains attached to the target and is the end point of the slipline. The target tracers are also redefined. The target package is no longer attached to the axis, but begins at the top slipline endpoint. (The tracers

between the axis and the slipline are plug and free surface tracers.) The indices of the tracers of each package that define the endpoints of the slipline($NBGSD_i$, $NBGMD_i$, $NENDSD_i$, $NENDMD_i$, i = i, NMAT) are changed as necessary at this time. (See Section 6.2.2.)

PLGVOL

When the plug is extended through another row of cells, PLGVOL is called to compute the partial cell volume of the plug material in the cell containing the extended plug surface. (See Section 6.2.4.2.)

PLUGUV

Once the plug has begun to evolve, the motion of the tracers on the plug interface is determined by special prescriptions in PLUGUV. These prescriptions are described in Section 6.2.3.

PTSAV

The intercepts between the slipline and grid lines are stored by subroutine PTSAV and used by subroutine THETAS to compute the angle of the slipline across each slipline cell. PTSAV is called by FRACS when a pair of master package tracers along the slipline are being used to compute a fractional cell face area. FRACS computes the intercept (in cm.) and PTSAV stores it in special arrays, XINT and YINT.

PTSAV uses a pointer array, MSLD, to associate the MFLAG and the i and j values of a cell with the intercept arrays, XINT and YINT, as follows:

MSLD (ms) = MFLAG (k)*1000000 + i*1000 + j

XINT (1,ms) → x-coordinate of the intercept at top of cell (k,i,j)

XINT (2,ms) → x-coordinate of the intercept at bottom of cell (k,i,j)

YINT (1,ms) → y-coordinate of the intercept at right of cell (k,i,j)

YINT (2,ms) → y-coordinate of the intercept at left of cell (k,i,j).

The XINT, YINT arrays are initialized on each subcycle of INFACE.

PTSAV also sets THETA (m) = 100 to indicate that the mixed cell k is cut by the slipline, where m = MFLAG (k) - 100.

REZONE

To add more material and diminish the number of zones in the active grid the REZONE routine combines either two cells (if rezoning in only one direction) or four cells (if rezoning in both directions) into one, and adds columns and/or rows to maintain an IMAX by JMAX grid. (See Section 8.1.)

REZONE is called from HELP only when certain input parameters (NUMREZ, REZ, IEXTX, JEXTY) are set. It can be "forced" on the first cycle of a restart run by setting REZ=1 in the input deck, or it can be "triggered" by TPHASE which sets REZ=1 when a signal reaches the edge of the grid.

RNDOFF

RNDOFF is called from DMADJ to insure that the sum of the mass transport terms of a given material exactly equals the mass of that material remaining in the cell. RNDOFF is called when a material is being evacuated or its transport terms are being adjusted to prevent a negative mass. (See Section 4.4.)

SETUP

SETUP defines several problem constants and reads the cards defining the DX and DY arrays, the initial conditions and strength properties of the material packages, and the parameters defining the slipline. SETUP also generates the passive tracer particles and writes the cycle 0 tape dump.

SETUPA

SETUPA defines the X, Y and TAU arrays and converts the tracer particle positions from centimeter to cell units. It moves tracer particles that are close to a grid boundary onto that boundary, and forces positions of corresponding tracers from different packages to be exactly equal. SETUPA also initializes some of the mixed cell arrays and calculates the initial value of ETH, the total theoretical energy of the material in the grid. CALFRC and FILGRD are called from SETUPA to define the properties of each cell in the grid. For plugging calculations PLGADD is called from SETUPA to generate additional tracer particles

SPHASE

In subroutine SPHASE, the deviator stresses acting on each cell face and the hoop stress are determined, and the resulting velocity and internal energy increments are computed. (Details are given in Sections 2.2.1 and 2.3.2,) SPHASE calls STRNG to compute the strength of the material in a cell. The effects of strength can be omitted and SPHASE bypassed by setting CYCPH3 = - 1.

STRNG

The yield strength of the material in a cell is computed by STRNG. (See Section 2.3.2.) The strength of a multi-material cell is a volume weighted average of the strength of its constituents. The strength constants for each material are defined by input cards when the problem is generated. STRNG is called from SPHASE.

THETAS

For calculations which use the slipline capability of the code (NOSLIP=0), THETAS is called to compute the angle of the slipline in each slipline cell for which PTSAV set THETA(m)=100. THETAS uses the intercepts saved by PTSAV to determine the angle of the slipline across a given slip cell. THETAS uses the first two non-zero cell boundary intercepts in this order:

top, bottom, right, and left. Therefore, if the slipline cuts the top, left, right, and bottom sides of a cell, THETAS uses only the top and bottom intercepts to define an average angle of the slipline through that cell.

TPHASE

Mass transport and the associated transport of momentum and energy are accounted for in TPHASE. (The numerical method is described in detail in Section 2.2.3.) Before printing a symbolic map which displays the material package numbers and interface cell locations, TPHASE redefines the flags of cells that have become pure.

TSETUP

TSETUP reads cards defining tracer particle locations. TSETUP generates, in centimeter coordinates, tracer particle positions which are on straight line segments or on arcs of circles or ellipses. (See Section 7.2.5.)

UC

Given the magnitude of the velocity components normal and tangential to the slipline (WN, WT), subroutine UC computes the radial component of velocity in the grid coordinate system.

UVCALC

UVCALC is called by HPHASE to update the velocities of materials in slipline cells. The new material velocities are determined by solving the four simultaneous linear equations described in Section 5.2. If a cell does not contain a slipline (THETA(m) < 0), HPHASE sets the material velocities (US, VS) equal to the updated cell-centered velocities (U, V).

UVMOD

After material and cell velocities are modified in TPHASE due to momentum transport, UVMOD is called to insure that the material velocities of slipline cells satisfy the requirement that the master and slave velocity components

normal to the slipline are equal and that the total momentum of the cell is conserved. (See Section 5.4.) UVMOD is not called if sliplines are not used (NOSLIP > 0).

VC

Given the magnitude of the velocity components normal and tangential to the slipline (WN,WT), subroutine VC computes the axial component of velocity in the grid coordinate system.

VDCLOS

Given the second index (NVRTEX) of the free surface tracer particle which is the vertex of a void closing region, VDCLOS applies three criteria to determine if the void should be closed up to the next free surface tracer. (See Section 8.4.)

If one of the criteria is met, VDCLOS moves two material tracers and one free surface tracer to a specified point on the free surface. The specified point then becomes the new vertex of the void closing region. Two free surface tracers are removed, and, in the region where the void was closed, the interface becomes only a material interface and is no longer a free surface.

VOLFND

VOLFND is part of the problem generator and is called only in the initial setup of a problem. VOLFND defines the volume and surface areas of a given material package in a mixed cell. VOLFND accomplishes this by using the XT, YT arrays which define the tracer particles belonging to that package and located in that cell. VOLFND adds tracer particles at appropriate corners of the cell, as well as one having the same coordinates as the first tracer in the XT, YT array. The arrays, XT, YT, now define an enclosed volume in such a way that, as one proceeds between two consecutive tracers, the given material package is to the left. VOLFND calculates the partial volume and fractional surface

areas for that material through the use of the theorems of Pappus. For the volume calculation, the theorem states the volume generated by a plane area that is rotated about a line that lies in its plane but does not intersect the area, is equal to the product of the area and the distance traveled by its center of gravity. For the surface area calculation, the theorem states the surface area generated by a line that is rotated about a line that lies in its plane but does not intersect the line, is equal to the product of the length of the line and the distance traveled by its center of gravity. The partial volume is stored in the VOLM array. The fractional surface areas are stored in FRACRT and FRACTP.

VOLFND also determines if the slipline lies in the mixed cell and, if so, calculates the angle THETA the slipline makes with the X-axis.

WN

Given radial and axial velocity components and the angle of the slipline, WN computes the magnitude of the velocity component normal to the slipline.

WT

Given radial and axial velocity components and the angle of the slipline, WT computes the magnitude of the velocity component tangent to the slipline.

XCTOP

XCTOP converts the x-coordinate of a point from cell to centimeter units.

XPTOC

XPTOC converts the x-coordinate of a point from centimeter to cell units.

YCTOP

YCTOP converts the y-coordinate of a point from cell to centimeter units.

YPTOC

YPTOC converts the y-coordinate of a point from centimeter to cell units.

10.3 DICTIONARY OF IMPORTANT VARIABLES

This section includes a description of the use, units, dimension and location of all variables in common blocks, as well as many variables local to the subroutines. The following conventions are used in the dictionary in describing the storage location of the variables:

(NAME)	The variable is local to subroutine NAME.
NAME	The variable is in common block NAME.
B.C.	The variable is in Blank Common or equivalenced to a variable in Blank Common.
=Z(N)	The variable is equivalenced to a member of the Z-array, the first array in Blank Common. Most of these variables are used in generating and restarting problems.
---	The variable is used as a calling argument.

In describing the dimensions of the variables the conventions are:

---	The variable is not dimensioned.
(30)	The array is always dimensioned 30.
(NVAR)	The dimension of the array must be greater than or equal to the value of NVAR, where NVAR is determined by the user when the calculation is generated. (See Appendix A for procedures for dimensioning the HELP arrays.)

Variable Name	Location	Dimension of Array	Units	Definition
A	(EQST)	----	----	"a" in the thermal pressure term of the Tillotson equation of state. (See Section 2.3.1.2) Also, "a" in the JWL equation of state for detonated explosives. (See Section 2.3.1.1)
AIX	B.C.	(KMAX)	ergs/g	Specific internal energy in a cell.
ALE	(MAP)	(41)	----	This array has alphabetic characters for positive values in the density (or compression), velocity, pressure and energy maps. Defined in a DATA statement.
ALFA	(EQST)	----	----	"α" in the Tillotson equation of state for hot, expanded materials (see Section 2.3.1.2). "α" in the JWL equation of state for a detonated high explosive. (See Section 2.3.1.1)
ALPHA	=Z(75)	---	radians	In PLGALF, ALPHA is the current angle of maximum shearing stress of a given cell. Used only in plugging calculations. In PLGTCR, PLGVOL and PLGMAS, it is

Variable Name	Location	Dimension of Array	Units	Definition
				the angle at which the plug edge is being extended.
ALPHSV	(PLGGEN)	----	radians	The angle of maximum shearing stress of material (associated with a passive tracer) which has just satisfied the plastic work criterion and is near the tip of the plug.
ALPSV	PLSTC	(IPLGRT, IPLGTP-IPLGBT+1)	radians	The angle of maximum shearing stress of each cell in the plugging region of the target is saved in the ALPSV array.
AMDM	B.C.	(NMAT)	----	The tensile failure criterion is based on material expansion. If ρ/ρ_o < AMDM, the material cannot support hydrostatic tensions or deviator stresses. (See Section 2.3.3)
AMMP	(TPHASE)	----	g	Mass transported across the right boundary of a cell. (See Section 10.4.2)
AMMU	(TPHASE)	----	g-cm/sec	Radial momentum transported across

Variable Name	Location	Dimension of Array	Units	Definition
				the bottom boundary of a cell. (See Section 10.4.2)
AMMV	(TPHASE)	----	g-cm/sec	Axial momentum transported across the bottom boundary of a cell. (See Section 10.4.2)
AMMY	(TPHASE)	----	g	Mass transported across the bottom boundary of a cell. (See Section 10.4.2)
AMPY	(TPHASE)	----	g	Mass transported across the top boundary of a cell. (See Section 10.4.2)
AMUR	(TPHASE)	----	g-cm/sec	Radial momentum transported across the right boundary of a cell. (See Section 10.4.2)
AMUT	(TPHASE)	----	g-cm/sec	Radial momentum transported across the top boundary of a cell. (See Section 10.4.2)
AMVR	(TPHASE)	----	g-cm/sec	Axial momentum transported across the right boundary of a cell. (See Section 10.4.2)
AMVT	(TPHASE)	----	g-cm/sec	Axial momentum transported across the top boundary of a cell. (See Section 10.4.2)

Variable Name	Location	Dimension of Array	Units	Definition
AMX	B.C.	(KMAX)	g	Total mass in a cell.
AN	(PLGGEN)	----	----	The number of passive tracers near the tip of the plug whose material has passed the plastic work criterion on a given cycle.
B	(EQST)	----	----	"b" in the thermal pressure term of the Tillotson equation of state. (See Section 2.3.1.2)
BBAR	=Z(149)	----	----	"$\overline{B}$" used in CDT. An INPUT parameter used in local sound-speed calculation for all materials other than an ideal gas. (Local sound-speed for material i in cell K is approximated as $(C_{oi})+\overline{B}\cdot\sqrt{P(K)}$, where the coefficient $\overline{B}$ is obtained by determining a typical slope for the isentropes in Ref.11 and using the relation $C = V\sqrt{-dP/dV}$ to evaluate $\overline{B}$ at a particular point.
BBOUND	=Z(74)	----	ergs	Calculated in SPHASE. Printed in EDIT under "Elastic Plastic Work." Total

Variable Name	Location	Dimension of Array	Units	Definition
				work done by the elastic and plastic stresses.
BETA	(EQST)	----	----	"β" in the Tillotson equation of state for hot, expanded materials. (See Section 2.3.1.2). "β" in the JWL equation. (See Section 2.3.1.1)
BOTM	=Z(39)	----	g	Calculated in TPHASE. Printed in EDIT. Total mass transported across bottom of grid.
BOTMU	=Z(64)	----	g-cm/sec	Calculated in TPHASE. Printed in EDIT. Total radial momentum transported across bottom of grid.
BOTMV	=Z(40)	----	g-cm/sec	Calculated in TPHASE. Printed in EDIT. Total axial momentum transported across bottom of grid.
CAPA	(EQST)	----	dynes/cm^2	"A" in the mechanical pressure term of the Tillotson equation of state and of the JWL equation of state for detonated explosives. (See Sections 2.3.1.1 and 2.3.1.2)
CAPB	(EQST)	----	dynes/cm^2	"B" in the mechanical pressure term of the Tillotson and JWL equations of state. (See Sections 2.3.1.1 and 2.3.1.2)

Variable Name	Location	Dimension of Array	Units	Definition
CKE	(HPHASE)	----	ergs	The kinetic energy of a slipline cell after the material velocities are updated by UVCALC.
CNAUT	MXCELL	(30)	cm/sec	"C_o" used in CDT. Approximate sound-speed of nineteen materials defined in a DATA Statement in COMDIM, the "included" element. $C_{oi} = \sqrt{\frac{ESCAPA_i}{RHOZ_i}} = \sqrt{A_i/\rho_{oi}}$
COMPC	(CMPRSN)	----	----	The compression of the material in cell k. Used in HPHASE to weight pressures and velocities, when necessary, in computing cell boundary values. (See Section 2.2.2.4)
CRATIO	=Z(148)	----	----	The cell boundary pressures and velocities are compression weighted in HPHASE if the ratio of the compressions of the two cells is greater than CRATIO, an input parameter. (See Section 2.2.2.4)
CSQR	B.C.	(NMAT)	dynes-cm/g	The constant energy compressibility of a material, computed and used in CDT in the pressure iteration. (See Section 4.6.1.1)

Variable Name	Location	Dimension of Array	Units	Definition
CVIS	=Z(27)	----	----	INPUT parameter. Used to describe the bottom boundary condition. The bottom grid boundary is transmittive when CVIS = -1, reflective when CVIS = 0.
CYC	B.C.	----	----	A flag used in DMCALC, DMADJ and set in INFACE, FRACS, SETUPA and NEWMIX. In DMCALC it is used as a factor in the computation of the mass transport terms and is greater than 1 only when NEWMIX calls DMCALC to make up subcycles for cells which become interface cells after the first subcycle of INFACE. In DMADJ, CYC = 0 means the mass transport terms have not been updated, and CYC = 1 means all subcycles of INFACE have been completed and the mass transport terms are updated. (See Section 4.4)
CYCLE	=Z(2)	----	----	Used in INPUT, MAP, SETUP, CDT, EDIT. Cycle number (an integer value in floating point form).

Variable Name	Location	Dimension of Array	Units	Definition
CYCMX	=Z(69)	----	----	INPUT parameter. Equals number of passes through INFACE on each cycle. Suggested minimum of 2 and maximum of 8. Used to minimize transport noise near interfaces.
CYCPH3	=Z(70)	----	----	INPUT parameter. Number of times to subcycle SPHASE. If it is set to -1, SPHASE is omitted.
CZERO	B.C.	(NMAT)	dynes/cm^2	Value of Y_o for calculation of material yield strength. Defined by input cards for each material package in the grid. Used in STRNG. (See Section 2.3.2.3)
DELEB	(TPHASE)	----	ergs	The total energy transported across the bottom boundary of a cell. (See Section 10.4.2)
DELER	(TPHASE)	----	ergs	The total energy transported across the right boundary of a cell. (See Section 10.4.2)
DELET	(TPHASE)	----	ergs	The total energy transported across the top boundary of a cell. (See Section 10.4.2)
DELM	(TPHASE)	----	g	Total change in mass of a cell.

Variable Name	Location	Dimension of Array	Units	Definition
DENGY	(ADDENG)	(30)	ergs/g	The specific internal energy released by a high explosive, defined in a DATA statement in ADDENG for four explosives.
DETIM	B.C.	(KMAX)	sec	The time for the HE detonation front to reach the center of a cell. If cell K does not contain high explosive, or if the explosive has been detonated, DETIM(K) = 0. If the problem does not involve an explosive the DETIM array can be dimensioned 1.
DISTX	(MOVTCR)	----	cm	The distance in the x-direction a tracer moves on a given subcycle of INFACE.
DISTY	(MOVTCR)	----	cm	The distance in the y-direction a tracer moves on a given subcycle of INFACE.
DMIN	=Z(24)	----	----	INPUT parameter. Allowable relative error in energy sum. When relative error is > DMIN, calculation is terminated. The relative energy error is checked in EDIT.

Variable Name	Location	Dimension of Array	Units	Definition
DNMS	(UVCALC)	----	g/cm^3	The average density of all the "master" materials in a slipline cell.
DNSL	(UVCALC)	----	g/cm^3	The average density of all the "slave" materials in a slipline cell.
DT	=Z(3)	----	sec	Time step $\Delta t = \left(\frac{(\Delta X, \Delta Y)min}{(C+(U,V)max)}\right)_{min} \cdot STAB.$ Calculated in CDT. (See CDT, Section 10.2)
DTFACT	(SPHASE)	----	----	Factor used in calculating a variable time step when subcycling the SPHASE calculations.
DTMIN	=Z(144)	----	sec	INPUT parameter. Used in CDT as time step cutoff. After STAB = FINAL, if DT < DTMIN execution is stopped.
DTNA	=Z(26)	----	sec	DT from previous time cycle. Used in INPUT, CDT, EDIT, HELP and REZONE.
DTSTR	(SPHASE)	----	sec	The time step used by SPHASE: DTSTR = DT*DTFACT. When SPHASE is not subcycled, DTFACT = 1 and DTSTR = DT.
DX	B.C.	(IMAX)	cm	The radial-dimension of cells.

Variable Name	Location	Dimension of Array	Units	Definition
DXF	=Z(136)	----	cm	DXF = DX(1) if the radial dimension of the cells is uniform.
DX00	B.C.	----	cm	DX00 = DX(0).
DY	B.C.	(JMAX)	cm	The axial-dimension of cells.
DYF	=Z(137)	----	cm	DYF = DY(1) if the axial dimension of the cells is uniform.
DY00	B.C.	----	cm	DY00 = DY(0).
EAMMP	(TPHASE)	----	ergs/g	Specific internal energy of mass transported across the right edge of a cell.
EAMPY	(TPHASE)	----	ergs/g	Specific internal energy of mass transported across the top of a cell.
ECK	=Z(76)	----	----	Used in EDIT. Relative error in energy sum: $ECK=\left(\sum_k E_k - ETH\right)/ETH$; where E_k is total energy in cell k. If $\lvert ECK \rvert >$ DMIN, execution is stopped.
EMIN	=Z(85)	----	ergs/g	INPUT parameter. Minimum specific internal energy to be used in the gamma-law equation of state. Usually EMIN $= 10^7$.

Variable Name	Location	Dimension of Array	Units	Definition
EMIX	(ENCHCK)	----	ergs	The sum of the energy in all the cells in the grid. Used by ENCHCK to compute the relative energy error after each phase of the cycle. This energy sum is computed using material velocities rather than cell-centered velocities in interface cells.
EMOB	=Z(150)	----	ergs	Calculated in TPHASE. Printed in EDIT. Total energy transported across bottom grid boundary.
EMOR	=Z(135)	----	ergs	Calculated in TPHASE. Printed in EDIT. Total energy transported across right grid boundary.
EMOT	=Z(146)	----	ergs	Calculated in TPHASE. Printed in EDIT. Total energy transported across top grid boundary.
ENERGY	B.C.	----	ergs/g	Defined in CDT as the specific internal energy of a cell or of a material in a multimaterial cell. Used in EQST to compute P = f(ENERGY, RHOW).
EOB	=Z(134)	----	ergs	Calculated in HPHASE and SPHASE. Printed in EDIT. Change in the energy of the grid due to work done at the bottom boundary of the grid. (See Section 3.3.2)

Variable Name	Location	Dimension of Array	Units	Definition
EOR	=Z(132)	----	ergs	Calculated in HPHASE and SPHASE. Printed in EDIT. Change in the energy of the grid due to work done at the right boundary of the grid. (See Section 3.3.2)
EOT	=Z(133)	----	ergs	Calculated in HPHASE and SPHASE. Printed in EDIT. Change in the energy of the grid due to work done at the top boundary of the grid. (See Section 3.3.2)
ERDUMP	B.C.	----	----	Used in EDIT and ERROR. Flags EDIT to do only a tape dump on an error exit.
ERR	(SPHASE)	(IMAX+1,3)	1/sec	The normal radial instantaneous strain rate associated with cell centers. (See Section 2.3.2.1)
ERRINT	MKPLUG	----	1/sec	The normal radial instantaneous strain rate corrected for convection. Computed in SPHASE, used to update deviator stress, S_{rr}, and to compute the angle of maximum shearing stress in PLGALF. (See Section 2.3.2.1)

Variable Name	Location	Dimension of Array	Units	Definition
ERZ	(SPHASE)	(IMAX+1,3)	1/sec	The instantaneous shear strain rate associated with cell centers. (See Section 2.3.2.1)
ERZINT	MKPLUG	----	1/sec	The instantaneous shear strain rate corrected for convection. Computed in SPHASE, used to update shear stress, S_{rz}, and to compute the angle of maximum shearing stress in PLGALF.
ES	(EQST)	----	ergs/g	E_s, the specific internal energy necessary to bring material to vapor temperature. If material is expanded and its specific internal energy is greater than E_s, but less than E_s', an equation of state is used which is a blend of the compressed and expanded formulations. (See Section 2.3.1.2)
ESA	(EQST)	(30)	----	Defined in DATA Statement. Values of "a" in equation of state for 19 inert materials & 4 explosives. [=(γ-1) when using perfect gas equation of state.]

Variable Name	Location	Dimension of Array	Units	Definition
ESALPH	(EQST)	(30)	----	Defined in DATA Statement. Values of "α" in equation of state for 19 inert materials and 4 explosives.
ESB	(EQST)	(30)	----	Defined in DATA Statement. Values of "b" in equation of state for 19 materials.
ESBETA	(EQST)	(30)	----	Defined in DATA Statement. Values of "β" in equation of state for 19 inert materials and 4 explosives.
ESCAPA	(EQST)	(30)	dynes/cm^2	Defined in DATA Statement. Values of "A" in equation of state for 19 inert materials and 4 explosives.
ESCAPB	(EQST)	(30)	dynes/cm^2	Defined in DATA Statement. Values of "B" in equation of state for 19 inert materials and 4 explosives.
ESES	(EQST)	(30)	ergs/g	Defined in DATA Statement. Values of "E_s" in equation of state for 19 inert materials.
ESESP	(EQST)	(30)	ergs/g	Defined in DATA Statement. Values of "E_s'" in equation of state for 19 inert materials.

Variable Name	Location	Dimension of Array	Units	Definition
ESEZ	(EQST)	(30)	ergs/g	Defined in DATA Statement. Values of "E_o" in equation of state for 19 inert materials.
ESP	(EQST)	----	ergs/g	E_s', the specific internal energy necessary to vaporize a material. If a material is expanded and its specific internal energy is greater than E_s' the expanded form of the Tillotson equation of state is used. (See Section 2.3.1.2)
ESUM	(EDIT, ENCHCK, UVMOD)	----	ergs	The sum of the energy in all the cells in the grid. Used by EDIT to compute the relative energy error. In ENCHCK, ESUM is the energy computed using cell centered velocities rather than material velocities in interface cells. (See EMIX.) In UVMOD, ESUM is the average specific internal energy of a slip-line cell.
ETA	(EQST)	----	----	ρ/ρ_o, the compression of a material. Used in EQST to compute the material pressure.

Variable Name	Location	Dimension of Array	Units	Definition
ETH	=Z(13)	----	ergs	Theoretical value of total energy in the mesh. Calculated in FILGRD initially.
EVAPEN	=Z(101)	----	ergs	Calculated in TPHASE and RNDOFF. Printed in EDIT. Sum of energy lost through "evaporation" of mass left in cells due to round-off error.
EVAPM	=Z(100)	----	g	Calculated in TPHASE and RNDOFF. Printed in EDIT. Sum of mass lost through "evaporation". See EVAPEN.
EVAPMU	=Z(102)	----	g-cm/sec	Calculated in TPHASE and RNDOFF. Printed in EDIT. Sum of radial momenta lost through "evaporation". See EVAPEN.
EVAPMV	=Z(103)	----	g-cm/sec	Calculated in TPHASE and RNDOFF. Sum of axial momenta lost through "evaporation". See EVAPEN.
EXPMIN	(EQST)	----	----	EXPMIN$\cdot(\rho_o)$ is the density which corresponds to a minimum value of the function $A\mu + B\mu^2$ used in the Tillotson equation of state. In order for the

Variable Name	Location	Dimension of Array	Units	Definition
				pressure iteration to converge, $P(\rho,E)$ must have a positive slope. (See Section 4.6.1.3)
EZ	(EQST)	----	ergs/g	E_0 in the thermal pressure term of the Tillotson equation of state. (See Section 2.3.1.2)
EZPH2	=Z(104)	----	ergs	Sum of the internal energy increments that are set to zero in TPHASE when Δ SIE < SIEMIN. Printed in EDIT.
EZZ	(SPHASE)	(IMAX+1,3)	1/sec	The normal axial instantaneous strain rate associated with cell centers. (See Section 2.3.2.1)
EZZINT	MKPLUG	----	1/sec	The normal axial instantaneous strain rate corrected for convection. Computed in SPHASE, used to update deviator stress, S_{zz}, and to compute the angle of maximum shearing stress in PLGALF.
FB	(DMADJ)	----	g	The mass being transported out of a cell across its bottom boundary. Computed and used by DMADJ to exactly evacuate materials from interface cells.

Variable Name	Location	Dimension of Array	Units	Definition
FINAL	=Z(113)	----	----	INPUT parameter. Maximum value of stability fraction (STAB). If FINAL = 0, the stability fraction will be constant. Used in CDT.
FL	(DMADJ)	----	g	The mass being transported out of a cell across its left boundary. (See FB)
FLEFT	B.C.	(JMAX)	g-cm/sec	Radial momentum of mass transported across left side of cell. Equivalenced to UL array. (See Section 10.4.2)
FLX	(DMADJ)	(4)	g	The mass transport terms for a given material at the four boundaries of a cell. Computed and used by DMADJ to adjust transport terms so that materials are not overemptied.
FR	(DMADJ)	----	g	The mass being transported out of a cell across its right boundary. (See FB)
FRACRT	B.C.	(NVOID, NMXCLS)	cm^2	The fractional area of the right cell boundary associated with a given material in an interface cell. Used to compute mass transport terms of that material.

Variable Name	Location	Dimension of Array	Units	Definition
FRACTP	B.C.	(NVOID, NMXCLS)	cm^2	The fractional area of the top cell boundary associated with a given material in an interface cell. Used to compute mass transport terms of that material.
FRACX	B.C.	----	----	The fraction of the x-dimension of the cell from the left of the cell to the intersection of the interface with the cell's top boundary. Used in NEWRHO, as well as in FRACS, to indicate which boundary of a cell is crossed by the interface. (Equivalenced to WSC in FRACS.)
FRACY	(FRACS)	----	----	The fraction of the y-dimension of the cell from the bottom of the cell to the intersection of the interface with the cell's right boundary.
FRX	(MOVTCR, PLGGEN, PLUGUV, FRACS)	----	----	The fractional part of the x-coordinate of a tracer (in cell units).
FRY	(MOVTCR, PLGGEN, PLUGUV, FRACS)	----	----	The fractional part of the y-coordinate of a tracer (in cell units).

Variable Name	Location	Dimension of Array	Units	Definition
FT	(DMADJ)	----	g	The mass being transported out of a cell across its top boundary. (See FB)
GAMC	B. C.	(JMAX)	g	Mass transported across the left side of a cell. Equivalenced to PL array. (See Section 10.4.2)
GAMGAS	(CDT)	(30)	----	A constant used in approximating the sound speed of a high explosive. Defined in a DATA statement in CDT for explosives. For ideal gas CDT sets GAMGAS(20)=GAMMA.
GAMMA	=Z(62)	----	----	INPUT parameter. "γ" in the ideal gas equation of state: $P = (\gamma-1)\rho E$. Used in EQST and CDT.
HOOP	(SPHASE)	----	$dynes/cm^2$	$S_{\theta\theta} = -(S_{rr}+S_{zz})$, the hoop stress, calculated when in cylindrical coordinates.
I	=Z(88)	----	----	Used in most subroutines as the index on the grid columns.
IB	----	----	----	A calling argument in DMCALC which identifies the leftmost column of the grid for which the mass

Variable Name	Location	Dimension of Array	Units	Definition
				transport terms of interface cells are to be computed (DMCALC is called from NEWMIX for a single cell and from INFACE for all interface cells in the active grid.)
ICLADD	=Z(38)	----	----	Flag used when detonating a high explosive. When ICLADD = - 1 either all explosives have been detonated or the problem does not involve explosives. (Defined in DETIME initially, later in ADDENG.) When ICLADD = 0 some explosive in the problem has not yet been detonated.
ICSTOP	=Z(7)	----	----	INPUT parameter. Used in EDIT. Execution stops on the ICSTOP cycle when stopping on a specified cycle rather than on time.
ICY	INF	----	----	The number of passes through INFACE (=INT(CYCMX)).
IDL	(MAP,TPHASE)	----	----	The rightmost column of the grid represented by the symbolic maps. On cycle 0, IDL=IMAX; thereafter IDL=I1, the radial active grid counter.

Variable Name	Location	Dimension of Array	Units	Definition
IDLT	=Z(19)	----	----	The leftmost column of the grid that contains a high explosive. Defined in DETIME.
IDRT	=Z(31)	----	----	The rightmost column of the grid that contains a high explosive. Defined in DETIME. When IDRT = 0, the calculation does not involve an explosive.
IE	----	----	----	A calling argument in DMCALC which indentifies the right-most column of the grid for DMCALC to compute (see IB).
IEXTX	=Z(123)	----	----	Used in REZONE and TPHASE. When IEXTX = 1 the grid is rezoned in the x-direction. Enables user to rezone in the x-direction only. Automatic rezones will not be triggered by signals reaching the right grid boundary unless IEXTX = 1.
IFLUX	(DMCALC)	----	----	In DMCALC, when IFLUX=1, the top and right mass transport terms are computed; when IFLUX=2, the bottom and left terms are computed for the cell in column IT and row JT.

Variable Name	Location	Dimension of Array	Units	Definition
IFS1	(DMCALC)	----	----	When IFS1=1, the cell (IT,JT) DMCALC is operating on is a free surface cell. This cell will not be the "donor" cell unless the neighbor cell is also a free surface cell (IFS2=1).
IFS2	(DMCALC)	----	----	When IFS2=1, the neighbor cell DMCALC is operating on is a free surface cell. This neighbor cell will not be the "donor" unless the cell (IT,JT) is also a free surface cell (IFS1=1).
IGM	=Z(21)	----	----	A flag which indicates which coordinate system is being used: IGM=1 for plane coordinates IGM=0 for cylindrical coordinates.
IMAX	=Z(33)	----	----	INPUT parameter. Number of columns in the mesh. IMAX must be an even number if the grid is to be rezoned in the x-direction.
INTER	=Z(87)	----	----	A flag which causes certain diagnostic messages to be printed each cycle. (See Section 9.2)
IPCYCL	=Z(49)	----	----	INPUT parameter. Used in EDIT. The number of cycles between EDIT prints when editing on cycles rather than on time.

Variable Name	Location	Dimension of Array	Units	Definition
IPLGBT	=Z(60)	----	----	The bottom-most row of the plugging region of the target. Used only in plugging calculations.
IPLGRT	=Z(56)	----	----	The right-most row of the plugging region of the target. Used only in plugging calculations.
IPLGTP	=Z(61)	----	----	The top-most row of the plugging region of the target. Used only in plugging calculations.
IPR	=Z(15)	----	----	Maximum number of iterations to be performed by CDT to achieve pressure equilibration between materials in multi-material cells.
ITC	(CDT)	----	----	The number of iterations CDT has processed while equilibrating the pressure of materials in a multi-material cell. If ITC exceeds the input cutoff, IPR, the calculation is stopped.
ITFLAG	(ADDTCR)	----	----	A flag used in ADDTCR. ITFLAG=0 when points are interpolated in physical coordinates (NADD>0). ITFLAG=1 when points are interpolated in cell units (NADD<0). The second option is used only when the cell dimensions are constant, in which case SETUPA sets NADD negative.

Variable Name	Location	Dimension of Array	Units	Definition
ITXB	(FRACS)	----	----	ITXB+1 is the column that contains the first tracer of a pair being considered by FRACS.
ITX1	(FRACS)	----	----	The vertical grid line crossed by the interface for which FRACS is computing a fractional cell face area.
ITX2	(FRACS)	----	----	ITX2+1 is the column that contains the second tracer of a pair being considered by FRACS.
ITYB	(FRACS)	----	----	ITYB+1 is the row that contains the first tracer of a pair being considered by FRACS.
ITY1	(FRACS)	----	----	The horizontal grid line crossed by the interface for which FRACS is computing a fractional cell face area.
ITY2	(FRACS)	----	----	ITY2+1 is the row that contains the second tracer of a pair being considered by FRACS.
IVARDX	=Z(83)	----	----	When IVARDX=1, the radial dimension of cells is non-uniform.
IVARDY	=Z(54)	----	----	When IVARDY=1, the axial dimension of cells is non-uniform.
I1	=Z(47)	----	----	INPUT parameter. I1 is used to limit the calculation in the radial direction to an "active mesh". Initially, I1=2 +

Variable Name	Location	Dimension of Array	Units	Definition
				the column-number of the last column in which a velocity and/or internal energy exists. Updated in HPHASE, TPHASE, ADDENG, and REZONE.
I2	=Z(48)	----	----	INPUT parameter. Like I1 but for the axial direction.
I3	B.C.	----	----	The rightmost column of cells printed by EDIT. I3=1 for a "short" print, I3=I1 (the radial edge of the active grid) for a "long" print.
J	=Z(89)	----	----	Used in most subroutines as index on the grid rows.
JB	----	----	----	A calling argument in DMCALC which identifies the bottom-most row of the grid for which the mass transport terms of interface cells are computed. (DMCALC is called from NEWMIX for a single cell and from INFACE for all interface cells in the active grid.)
JDBT	=Z(28)	----	----	The bottom row of the grid that contains a high explosive. Defined in DETIME.
JDL	(MAP,TPHASE)	----	----	The topmost row of the grid represented by the symbolic maps. On cycle 0, JDL=JMAX; thereafter, JDL=I2, the axial active grid counter.

Variable Name	Location	Dimension of Array	Units	Definition
JDTP	=Z(29)	----	----	The topmost row of the grid that contains a high explosive. Defined in DETIME.
JE	----	----	----	A calling argument in DMCALC which identifies the topmost row of the grid for DMCALC to compute (see JB).
JEXTY	=Z(124)	----	----	A flag used in REZONE. When JEXTY = 1, the grid is rezoned in the y-direction. Enables user to rezone in y-direction only. Automatic rezones will not be triggered by signals reaching the upper grid boundary unless JEXTY = 1.
JMAX	=Z(35)	----	----	INPUT parameter. Number of rows in the grid. JMAX must be an even number if the grid is to be rezoned in the y-direction.
JSLIP	(PLGTCR)	----	----	The row across which the plug is being extended.
K	=Z(90)	----	----	Used as cell-index in all subroutines. K=(J-1)*IMAX+I+1.
KA	B.C.	----	----	Used as cell-index for the cell above K. KA = K + IMAX.

Variable Name	Location	Dimension of Array	Units	Definition
KB	(DMCALC,SPHASE)	----	----	Used as cell-index for the cell below cell K. KB=K-IMAX.
KDT	(EDIT,INPUT, SETUP)	----	----	The number of words in the DETIM array written on the restart file. KDT = 1 if there is no explosive in the problem; otherwise, KDT = KMAX.
KI	MOV	(4)	----	The K-indices of the four overlap cells used to compute the velocity components of a tracer particle.
KMAX	=Z(37)	----	----	Calculated in SETUP (=IMAX*JMAX+1). K-index of the last cell in the grid.
KPW	(EDIT,INPUT, SETUP)	----	----	The number of words in the PLWP array written on the restart file. KPW=1, if the plugging option is not being used; otherwise, KPW=NTCC, the number of passive tracers.
KSPACE	(EDIT)	----	----	Used for spacing printed output.
KSS	(EDIT,INPUT, SETUP)	----	----	The number of words in the STRSZZ, STRSRR and the STRSRZ arrays written on the restart file. KSS=1 if the strength phase is omitted (CYCPH3= -1); otherwise,KSS=KMAX.
KUNITR	=Z(14)	----	----	Number of the file read by INPUT.

Variable Name	Location	Dimension of Array	Units	Definition
KUNITW	=Z(17)	----	----	Number of the file written on by SETUP and EDIT.
LABLE	=Z(1)	(1)	----	An array used by CARDS to store integer variables in the Z-block of blank common.
LAST	B.C.	----	----	The last word of blank common. Used in the main routine to initialize the blank common storage to zero.
LJ	INF	----	----	The number of the INFACE subcycle. (LJ goes from 1 to ICY.)
LSAVE	(CDT,PLGTCR)	----	----	In CDT - the material package number of the only material in an interface cell that contains only one material. In PLGTCR - the second index of the target tracer to the right of the intercept of the plug edge with the back surface of the target.
LVF	(MOVTCR, ENDMV)	----	----	The second index of a void tracer that corresponds to a given material tracer.
LVISC	=Z(116)	----	----	A linear artificial viscosity term is added to the cell boundary pressures when LVISC=1.
M	=Z(91)	----	----	Usually the index which links the material arrays to cell K: M = MFLAG(K)-100 and $AMX(K)=\sum_{n} XMASS(N,M)$.

Variable Name	Location	Dimension of Array	Units	Definition
MA	B.C.	----	----	Usually the value of MFLAG for the cell above cell K.
MAPS	= Z(42)	----	----	INPUT parameter that determines the printing of symbolic maps on EDIT cycles. If MAPS = 0, maps are not printed; if MAPS = 1, they are printed and the first map is of compression; if MAPS = 2, they are printed and the first map is of density.
MASTER	(FRACS)	----	----	While processing the package n interface, FRACS sets MASTER = n if package n is a "master" package. Its tracers will be used to compute the angle of the slipline in each slipline cell.
MASTRD	SLIDPK	(NMAT)	----	If MASTRD(n) = n, then package n is a master package and all or part of the package n interface is a slipline. If MASTRD(n)=0, then package n is a slave package (NSLAVD(n) = n) or it is neither and no part of its interface is a slipline.

Variable Name	Location	Dimension of Array	Units	Definition
MAT	MXCELL	(30)	----	Material code numbers for the packages. MAT(1)=3 indicates the material in package one is iron. See list in Section 2.3.1 of this report or comments in the EQST subroutine.
MAXX	=Z(120)	----	----	Used in ADDTCR. Right column and top row, respectively, of the region in which tracer particles are to be added (see NADD, MINX, MINY).
MAXY	=Z(122)	----	----	
MFLAG	B.C.	(KMAX)	----	A flag which indicates whether a cell is pure or contains an interface. If MFLAG(K) < 100, cell K is pure. If MFLAG(K) > 100, cell K contains an interface and the flag gives the storage location in the material arrays for cell K.
MINX	=Z(119)	----	----	Used in ADDTCR. Left column and bottom row, respectively, of the region in which tracer particles are to be added (see NADD, MAXX, MAXY).
MINY	=Z(121)	----	----	
MO	B.C.	----	----	The MFLAG(K) of cell K when it was pure. Used by NEWMIX to define the material variables (XMASS, SIE, US, VS, etc.) of a cell that has just become an interface cell.

Variable Name	Location	Dimension of Array	Units	Definition
MOS	B.C.	----	----	The number of cells containing the slipline on any one cycle. Incremented in PTSAV which saves the slipline intercepts with cell boundaries.
MPLUS	(ADDTCR)	----	----	An accumulative number of tracers added to a subpackage or package.
MR	B.C.	----	----	Usually the value of MFLAG for the cell on the right of cell K.
MSLD	SLIDE	(NSLD)	----	A flag word for each slipline cell which stores its I,J, and MFLAG(K) values: $MSLD(MS)=MFLAG(K)*10^6 + I*10^3 + J$. This allows the user to have smaller dimensions for the slipline arrays XINT, YINT than for the THETA array which is associated with <u>every</u> interface cell.
MTK	MOV	(4)	----	The MFLAG values of the four overlap cells used to compute the velocity components of a tracer particle.
N	=Z(92)	----	----	In EQST, N is the material code number transferred from CDT.
NAD	(ADDTCR, EDIT,PLGADD)	----	----	Temporary storage for NADD in ADDTCR. In PLGADD, NAD is the number of tracers added at the corner where the plug will begin. In EDIT, NAD = |NADD|.

Variable Name	Location	Dimension of Array	Units	Definition
NADD	=Z(118)	----	----	NADD has two functions. In EDIT it controls the frequency of calls to ADDTCR. In ADDTCR it is used to determine how many tracers to add between two existing tracers. Its input value is saved in NAD and restored at the end of ADDTCR. (See Section 8.2)
NAME	(ENCHCK)	----	----	A string of hollerith symbols passed by HELP through a calling argument which identifies which phase of the calculation (SPHASE, HPHASE, or TPHASE) has just been completed.
NBGMD	SLIDPK	(NMAT)	----	The second index of the tracer which begins the slipline of a master package.
NBGP	(THETAS)	----	----	The slave package whose "beginning" slipline tracer (NBGSD) is an endpoint of the slipline.
NBGSD	SLIDPK	(NMAT)	----	The second index of the tracer which begins the slipline of a slave package.
NC	=Z(30)	----	----	Cycle number. Set initially to -1 in INPUT. Incremented thereafter in CDT. (Decremented in INPUT when restarting a calculation.)
NDUMP7	=Z(6)	----	----	INPUT parameter. Used in EDIT to control frequency of restart dumps, e.g., a dump will occur on every EDIT print when NDUMP7 = 1, or on every fifth EDIT print when NDUMP7 = 5.

Variable Name	Location	Dimension of Array	Units	Definition
NECYCL	=Z(77)	----	----	Defined and printed in EDIT. The cycle on which the largest relative error in the energy sum was computed.
NEND	(ENDMV)	----	----	The second index of the plug tracer which is at the top of the slipline.
NENDMD	SLIDPK	(NMAT)	----	The second index of the tracer which ends the slipline of a master package.
NENDMI	=Z(108)	----	----	The second index of what is initially the last target tracer defining the slipline. The slip-line gets extended along the target boundary to allow the projectile lip to slip on the target. Used only in plugging calculations.
NENDSD	SLIDPK	(NMAT)	----	The second index of the tracer which ends the slipline of a slave package.
NENP	(THETAS)	----	----	The slave package whose "ending" slipline tracer (NENDSD) is an endpoint of the slipline.
NERR	B.C.	----	----	Used in ERROR as exit flag. Prevents ERROR from being called more than once during a single run.
NFLAG	(CDT)	----	----	A counter used in the pressure iteration to count the number of times the weighting factor, CSQR, is doubled to give all materials

Variable Name	Location	Dimension of Array	Units	Definition
				a positive partial volume. If NFLAG exceeds the input cut-off, IPR, the calculation is stopped.
NFRELP	=Z(5)	----	----	INPUT parameter. Used in EDIT to control frequency of "long" prints. A "long" print will occur with every EDIT if NFRELP = 1; when every fifth EDIT if NFRELP = 5.
NK	B.C.	----	----	Tells which statement number of a subroutine is near the call to ERROR.
NLINER	=Z(105)	----	----	The package number of the material that forms the jet of a shaped charge. Used only when calculating the collapse of a shaped charge liner.
NMAT	=Z(68)	----	----	The number of material packages in the problem. (Note: each material package can be made up of several disconnected subpackages. Also two packages <u>can</u> contain the same material but have different initial conditions.)
NMP	B.C.	(NMAT)	----	The number of tracer particles used to circumscribe the boundary of a given material package.
NMXCLS	=Z(73)	----	----	The maximum number of interface cells that SETUP or NEWMIX can generate. This number should coincide with the dimension of variables in the MXCELL common block.

Variable Name	Location	Dimension of Array	Units	Definition
NODUMP	=Z(96)	----	----	INPUT parameter. Used in EDIT. When NODUMP=1 no restart dumps are written except by SETUP on cycle 0. Allows user to restart a problem without writing on the restart file.
NOSLIP	=Z(115)	----	----	A flag which when set to 1 indicates the calculation has no sliplines.
NPRINT	B.C.	----	----	NPRINT=1 during the cycle on which EDIT prints and checks the energy error.
NR	B.C.	----	----	Identifies which subroutine calls ERROR. Used in ERROR for printing error message.
NRC	(TPHASE)	----	----	Used in TPHASE to signal that the active grid must be enlarged one column on the right.
NREC	(INPUT)	----	----	The number of logical records in each restart dump.
NRT	(TPHASE)	----	----	Used in TPHASE to signal that the active grid must be enlarged one row at the top.
NSAVE	(FLGSET)	----	----	The package number of a material in a cell which was generated as an interface cell but is flagged a pure cell by FRACS and FLGSET.
NSLAVD	SLIDPK	(NMAT)	----	If NSLAVD(n)=n, then package n is a slave package and all or part

Variable Name	Location	Dimension of Array	Units	Definition
				of the package n interface is a slipline. If NSLAVD(n)= 0, then package n is either a master package (MASTRD(n)= n) or no part of its interface is a slipline.
NSLD	=Z(112)	----	----	The maximum number of slipline cells in the grid on any one cycle. This number should coincide with the dimension of the variables in the SLIDE common block.
NSLPMN	=Z(107)	----	----	The initial value of NBGSD(2). (Used only in plugging calculations). Updated in PLGTCR so that NSLPMX-NSLPMN+1 is the number of identical tracers at the corner of the plug, as the plug evolves.
NSLPMX	=Z(106)	----	----	The initial value of NENDSD(2). Used in plugging calculations only.
NTCC	=Z(81)	----	----	INPUT parameter. When NTCC>0 passive cell centered tracers are used.
NTPMX	=Z(78)	----	----	INPUT parameter. Equals the maximum number of tracers that SETUP or ADDTCR can generate to circumscribe a single material package. The value of this number should coincide with the dimension of the TX and TY arrays.

Variable Name	Location	Dimension of Array	Units	Definition
NTRACR	=Z(72)	----	----	INPUT parameter. Used to determine the density of material tracer particles. (See Section 8.2)
NUMREZ	=Z(12)	----	----	INPUT parameter. Initially equals the number of automatic rezones allowed during a calculation. Diminished by one after each rezone.
NUMSCA	=Z(43)	----	----	INPUT parameter. Number of times the print interval is to be rescaled. Used in EDIT. See PRDELT for further details.
NUMSP	=Z(4)	----	----	Used in EDIT to count the number of "short" prints since the last "long" print. When NUMSP=NFRELP, EDIT produces a "long" print, i.e., information on all the cells in the active grid, rather than just on the cells in the first column.
NUMSPT	=Z(41)	----	----	Used in EDIT to count the number of prints (short or long) since the last tape dump.
NUNxxx	=Z(xxx)	----	----	Unused Z-storage.
NVOID	B.C.	----	----	Defined in INPUT: =NMAT + 1, number of material packages +1. The number of the void package if there is one.

Variable Name	Location	Dimension of Array	Units	Definition
NVP	(MOVTCR)	----	----	The number of material packages plus one. Used as a limit on the do-loop which moves the tracer particles. The void tracers are moved simultaneously with the material tracers and the passive tracers are moved (on the last subcycle of INFACE) when N=NVP.
NVRTEX	=Z(109)	----	----	The second index of the void tracer at the vertex of the void closing region. If NVRTEX=0, the code does not call VDCLOS to automatically close a void.
N10	(CDT)	----	----	Used in CDT to identify the I-index of the cell which controls the time step.
N11	(CDT)	----	----	Used in CDT to identify the J-index of the cell which controls the time step.
OKE	(HPHASE)	----	ergs	The kinetic energy of a slipline cell before its material velocities are updated in UVCALC.
OUTFLX	(DMCALC)	----	g	The total mass of a material being transported out of an interface cell. Computed by DMADJ to see if the mass going out exceeds the mass in the cell. The mass transport terms are adjusted accordingly to prevent negative masses.

Variable Name	Location	Dimension of Array	Units	Definition
OUTIE	B.C.	(NMAT)	ergs	The total internal energy lost from each package due to "evaporation", cut-offs, or material leaving the grid. Printed by EDIT.
OUTKE	B.C.	(NMAT)	ergs	The total kinetic energy lost from each package due to "evaporation", cut-offs, or material leaving the grid. Printed by EDIT.
P	B.C.	(KMAX)	dynes/cm^2	Cell pressure. Note that the P-storage is used by other arrays in INFACE, REZONE, and TPHASE. See equivalence statements in the "included" element.
PABOVE	(HPHASE)	----	dynes/cm^2	The pressure at the boundary between cell k and the cell above it, an average of the cell-centered pressures of the two cells.
PAV	(CDT)	----	dynes/cm^2	The weighted average pressure computed in the pressure iteration to which the pressures of all materials must converge. (See Section 4.6.1.2)
PBLO	(HPHASE)	----	dynes/cm^2	The pressure at the boundary between cell k and the cell below it, an average of the cell-centered pressures of the two cells.
PI	=Z(8)	----	----	π
PIDY	=Z(8)	----	----	π

Variable Name	Location	Dimension of Array	Units	Definition
PK	B.C.	(5)	----	The first array following the 150 word Z-block. PK(1) = problem number, PK(2) = restart cycle, PK(3) = restart flag. Note: PK(1) is equivalent to Z(151) and in the SETUP deck must be set equal to PROB (Z(1)). PK(2) and PK(3) are defined in the restart deck.
PL	B.C.	(See definition of JDX2 parameter in Appendix A)	$dynes/cm^2$	Used in HPHASE to store the pressure at the boundary between cell k and the cell on its left, an average of the cell-centered pressures of the two cells. (Saved values of PRR when column on left was being processed.) Storage used for other purposes in CDT, MAP, and TPHASE.
PLGOPT	=Z(111)	----	----	Flag set to 1 when using plugging failure model. If PLGOPT=0, a plug will not be generated by the code.
PLUGON	=Z(125)	----	----	When PLUGON=1, the vertical edge of the plug package has been extended at least one row into the target. (The plug package now has a non-zero volume.) Used only when plugging option is being used.
PLW	MXCELL	(NMAT)	ergs	The total plastic work done by each material package.

Variable Name	Location	Dimension of Array	Units	Definition
PLWC	PLSTC	(IPLGRT, IPLGTP-IPLGBT+1)	ergs/g	An array which stores a specific plastic work increment for each cell in the plugging region of the target. Used only when the plugging option is activated to update the PLWP array.
PLWMIN	=Z(59)	----	ergs/g	The specific plastic work of the material near the top right edge of the plug must exceed PLWMIN before the plug edge will be extended.
PLWP	PLSTC	(NTCC)	ergs/g	An array which stores the accumulated specific plastic work of the material associated with each passive tracer particle in the plugging region of the target. Used only when the plugging option is activated.
PMIN	=Z(86)	----	dynes/cm^2	A pressure cutoff. When $\|P(K)\|$<PMIN then P(K) is set to zero.
POSX	(MOVTCR)	----	cm	The new x-coordinate of a tracer in centimeters.
POSY	(MOVTCR)	----	cm	The new y-coordinate of a tracer in centimeters.
PR	B.C.	(IMAX)	----	The first two words of a restart dump are read from the file and stored in PR(1)(the flag word = 555.0 or 666.0) and

Variable Name	Location	Dimension of Array	Units	Definition
				PR(2)(the cycle number of the dump). In MAP the PR array is used to store a row of hollerith symbols to be printed in one of the symbolic maps.
PRCNT	=Z(16)	----	----	Convergence requirement for equilibrating pressures in a multi-material cell. If $\left\|\frac{P_i - \bar{P}}{\bar{P}}\right\| \leq$ PRCNT for all materials (i) in cell K, then $P(K) = \bar{P}$.
PRDELT	=Z(45)	----	sec	INPUT parameter. Gives the initial time interval between EDIT prints. There are five parameters which control printing frequency: PRDELT, IPCYCL, PRLIM, PRFACT, and NUMSCA. If the user is printing on time (PRDELT≠0 and IPCYCL=0), DT will be adjusted so that a print will occur exactly every PRDELT seconds. If the user is printing on cycles (PRDELT=0, IPCYCL≠0), a print will occur every IPCYCL cycles. PRLIM, PRFACT and NUMSCA are used to increase the print interval. PRLIM is the time (or cycle) at which PRDELT (or IPCYCL) and PRLIM are multiplied by PRFACT. The new value of PRLIM establishes the next time (or cycle) when the print interval will again be rescaled. This

Variable Name	Location	Dimension of Array	Units	Definition
				process continues at most NUMSCA times. EXAMPLE: You wish to print every 1×10^{-8} sec until you reach 1×10^{-7} sec, then every 1×10^{-7} sec until 1×10^{-6} sec and every 1×10^{-6} sec thereafter: PRDELT = 1×10^{-8} PRLIM = 1×10^{-7} PRFACT = 10 NUMSCA = 2.
PRESUR	B.C.	----	dynes/cm^2	Defined in EQST: pressure = $f(\rho,E)$. Used in CDT to define P(K) in the case of pure cells, and in the case of multimaterial cells to define PRS(1,i), the pressure of material (i).
PRFACT	=Z(46)	----	----	INPUT parameter. Used in EDIT for rescaling PRDELT, IPCYCL and PRLIM when the PRLIM time (or cycle) is reached (see PRDELT). Must be > 1.
PRLIM	=Z(44)	----	----	INPUT parameter: time or cycle at which to rescale PRDELT (or IPCYCL) and PRLIM by PRFACT (see PRDELT).
PROB	=Z(1)	----	----	INPUT parameter. Identifying problem number. Must be between 0.0001 and 99.9999, inclusively.
PROP	B.C.	(IMAX)	----	Used by MAP to store a row of cell quantities to be represented by a symbolic map.

Variable Name	Location	Dimension of Array	Units	Definition
PRR	(HPHASE)	----	dynes/cm^2	The pressure at the boundary between cell k and the cell on its right, an average of the cell-centered pressures of the two cells.
PRTIME	=Z(131)	----	sec	Initially set to PRDELT in INPUT. Thereafter calculated in EDIT. When T=PRTIME, it is time to print and PRTIME becomes T + PRDELT, the next time to print.
PSUM	(CDT)	----	----	Used as a flag in CDT. If the pressures of all the materials in a multi-material cell are less than PMIN, PSUM=0, which flags the code to set the cell pressure to zero.
PVOL	PLSTC	(IPLGRT)	cm^3	The volume associated with the plug package in a cell into which the vertical edge of the plug has been extended. Used to convert target mass into plug mass in PLGMAS. Computed in PLGVOL. Used only when the plugging option is activated.
PVOL3	(PLGMAS)	----	cm^3	The volume of the target material in a cell into which the plug edge has been extended.
PVRTEX	B.C.	----	dynes/cm^2	The hydrostatic pressure of the cell which contains the vertex point of the void closing region. See Section 8.4.

Variable Name	Location	Dimension of Array	Units	Definition
QA QB QL QR	(HPHASE)	----	$dynes/cm^2$	The linear artificial viscosity term added to the top, bottom, left, and right cell boundary pressures, respectively. A different viscosity can be used by redefining these variables. (See Section 2.2.2.5)
RATIO	(CDT, DMADJ, HPHASE)	----	sec (in CDT)	Used in the calculation of DT: the ratio of $(DX,DY)_{min}$ to $[(U,V)_{max}$ + local sound $speed]_{max}$ for a given cell. In DMADJ and HPHASE used as ratio of masses and compressions, respectively
RELERR	(EDIT, ENCHCK)	----	----	Used for storing and printing maximum relative error in the energy sum.
REZ	=Z(95)	----	----	A flag used to activate a grid rezone. Can be set by the user on a restart cycle or by the code if NUMREZ is greater than 0. (See Section 8.1.3)
RHO	MXCELL	(NVOID, NMXCLS)	g/cm^3	The density of the materials in an interface cell. If RHO (NVOID,m)=1 the interface cell K (where m = MFLAG(K)-100) is a free surface cell. If RHO(n,m)>0, the interface of package n crosses the cell, and if RHO(n,m) = 0, the n interface does not cross the cell, and any material n in the cell must be "evacuated". The RHO

Variable Name	Location	Dimension of Array	Units	Definition
				array is used as a flag as well as a material property. (See Section 4.2)
RHOC	(SPHASE)	(IMAX+1,3)	g/cm^3	The average cell density of three rows of cells.
RHOIN	B.C.	(NMAT)	g/cm^3	The initial material density for each package. Defined by input cards read by SETUP.
RHOMAX	(CDT)	(30)	g/cm^3	The density of a high explosive corresponding to a maximum point in the JWL equation of state. The density of HE in a multi-material cell is not allowed to exceed RHOMAX during the pressure iteration. Defined in a DATA statement for four explosives.
RHOW	B.C.	-----	g/cm^3	Density of material. Defined in CDT and used in EQST to define pressure: P = f(ENERGY,RHOW).
RHOZ	MXCELL	(30)	g/cm^3	Defined in DATA statement in COMDIM, the "included" element. Normal density for 19 materials.
RHOZR	(EQST)	----	g/cm^3	ρ_o of a given material. Used in the Tillotson and JWL equations of state. RHOZR=RHOZ(n)

Variable Name	Location	Dimension of Array	Units	Definition
				where RHOZ is defined in a DATA statement in the "included" element. (See Section 2.3.1.)
RMOM	B.C.	----	g-cm/sec	The total post-HPHASE radial momentum of a slipline cell. Computed in HPHASE; used in UVCALC to update the master and slave material velocities. (See Section 5.2.)
RMU	B.C.	(NMAT)	$dynes/cm^2$	Rigidity modulus of each material package. Defined by input cards read by SETUP. Used in SPHASE.
ROEPS	=Z(110)	----	----	INPUT parameter. A round-off epsilon used in calculating cutoffs of energy, velocity and mass.
RTM	=Z(57)	----	g	Calculated in TPHASE. Printed in EDIT. Total mass lost out right side of grid.
RTMU	=Z(10)	----	g-cm/sec	Calculated in TPHASE. Printed in EDIT. Total radial-momentum lost out right side of grid.
RTMV	=Z(58)	----	g-cm/sec	Calculated in TPHASE. Printed in EDIT. Total axial-momentum lost out right side of grid.
RTX	(FRACS)	----	----	The grid line which is the right boundary of the cell being processed by FRACS.

Variable Name	Location	Dimension of Array	Units	Definition
RTY	B.C.	----	----	The distance from the bottom of the grid to the intercept of an interface with a cell's right boundary, converted to cell units. Used in NEWRHO as well as in FRACS. (Equivalenced to WSY in FRACS.)
SALPHA	=Z(138)	----	radians	The angle with the x-axis at which the vertical edge of the plug was last extended. Initially, SALPHA=$\pi/2$ in INPUT. Used only for plugging calculations.
SAMMP	MXCELL	(NMAT, NMXCLS)	g	The mass of material package n which is transported across the right boundary of interface cell K is stored in SAMMP(n,m), where m = MFLAG(K)-100. If SAMMP(n,m) > 0, the mass is moving out of the cell; otherwise, it is moving into the cell. Computed in DMCALC. (See Section 10.4.2)
SAMMU	SL	(NMAT)	g-cm/sec	The radial momentum of a given material transported across the bottom of an interface cell. (See Section 10.4.2)
SAMMV	SL	(NMAT)	g-cm/sec	The axial momentum of a given material transported across the bottom of an interface cell. (See Section 10.4.2)

Variable Name	Location	Dimension of Array	Units	Definition
SAMMY	MXCELL	(NMAT, NMXCLS)	g	The mass of material package n which is transported across the bottom boundary of interface cell K is stored in SAMMY (n,m), where m = MFLAG(K)-100. If SAMMY(n,m) >0, the mass is moving into the cell; otherwise, it is moving out of the cell. Computed in DMCALC. (See Section 10.4.2)
SAMPY	MXCELL	(NMAT, NMXCLS)	g	The mass of material package n which is transported across the top boundary of interface cell K is stored in SAMPY(n,m), where m = MFLAG(K) -100. If SAMPY(n,m) > 0, the mass is moving out of the cell; otherwise, it is moving into the cell. Computed in DMCALC. (See Section 10.4.2)
SAMUR	SL	(NMAT)	g-cm/sec	The radial momentum of a given material transported across the right of an interface cell. (See Section 10.4.2)
SAMUT	SL	(NMAT)	g-cm/sec	The radial momentum of a given material transported across the top of an interface cell. (See Section 10.4.2)

Variable Name	Location	Dimension of Array	Units	Definition
SAMVR	SL	(NMAT)	g-cm/sec	The axial momentum of a given material transported across the right of an interface cell. (See Section 10.4.2)
SAMVT	SL	(NMAT)	g-cm/sec	The axial momentum of a given material transported across the top of an interface cell. (See Section 10.4.2)
SCALE	(MAP)	----	----	A scale factor used to determine which alphabetic symbol to associate with a given cell quantity. SCALE is based on the minimum and maximum of that quantity as well as the number of characters to be used by the symbolic map.
SDELEB	B.C.	(NMAT)	ergs	The internal energy of a given material transported across the bottom boundary of an interface cell. (See Section 10.4.2)
SDELER	B.C.	(NMAT)	ergs	The internal energy of a given material transported across the right boundary of an interface cell. (See Section 10.4.2)
SDELET	B.C.	(NMAT)	ergs	The internal energy of a given material transported across the top boundary of interface cell. (See Section 10.4.2)

Variable Name	Location	Dimension of Array	Units	Definition
SDELM	B.C.	(NMAT)	g	The total change in the mass of a given material in an interface cell due to transport.
SDT	B.C.	----	sec	Defined in INFACE (SDT=DT/CYCMX). Time step for each subcycle of INFACE.
SFLEFT	B.C.	(NMAT, JMAX)	g-cm/sec	The radial momentum of a given material transported across the left boundary of an interface cell. (See Section 10.4.2)
SGAMC	MXCELL	(NMAT, NMXCLS)	g	The mass of material package n which is transported across the left boundary of interface cell K is stored in SGAMC(n,m), where m = MFLAG(K) -100. If SGAMC(n,m) > 0, the mass is moving <u>into</u> cell K; otherwise, it is moving <u>out</u> of the cell. Computed in DMCALC. (See Section 10.4.2)
SIE	MXCELL	(NMAT, NMXCLS)	ergs/g	The specific internal energy of materials in interface cells. These materials have specific internal energies different from the cell specific internal energy, AIX, which is a mass weighted average of the material specific internal energies. (See Section 4.2)

Variable Name	Location	Dimension of Array	Units	Definition
SIEMIN	=Z(82)	----	ergs/g	The cutoff on the specific internal energy increment in the transport phase (TPHASE). If this increment is less than SIEMIN, the increment is set to zero and ETH is adjusted accordingly.
SIGC	B.C.	(JMAX)	ergs	The total energy of the mass transported across the left side of a cell in TPHASE. Equivalenced to PL. (See Section 10.4.2)
SIGMU	(TPHASE)	----	g-cm/sec	Total change in radial momentum of a cell.
SIGMV	(TPHASE)	----	g-cm/sec	Total change in axial momentum of a cell.
SLOPS	(PLGTCR)	----	----	The slope of the extended edge of the plug. See SLOPT.
SLOPT	(PLGTCR)	----	----	The slope of the back surface of the target between two consecutive tracer particles. Used to compute the intercept of the plug edge with the back surface of the target.
SLPNDX	=Z(22)	----	----	The x-coordinate (in cell units) of the top of the slipline in a plugging calculation. Until the plug is completely formed, the top of the slipline is the last grid line the

Variable Name	Location	Dimension of Array	Units	Definition
				vertical edge of the plug was extended to, although the top of the plug itself can move beyond that grid line. See TXCL.
SLPNDY	=Z(23)	----	----	The y-coordinate (in cell units) of the top of the slipline in a plugging calculation. See SLPNDX and TYCL.
SNB	(SPHASE)	(IMAX+1)	$dynes/cm^2$	Normal deviator stress at bottom of a cell.
SNL	(SPHASE)	----	$dynes/cm^2$	Normal deviator stress at left of cell.
SNLX	(SPHASE)	----	dynes/cm	= SNL*X(I-1) for cell in column I.
SNR	(SPHASE)	----	$dynes/cm^2$	Normal deviator stress at right of a cell.
SNT	(SPHASE)	----	$dynes/cm^2$	Normal deviator stress at top of a cell.
SOLID	(STRNG, SPHASE)	----	g/cm^3	$= RHOZ_i * AMDM_i$. If $RHO_i <$ SOLID for any material in cell K, the deviator stresses of cell K are set to zero.
SRATIO	(CDT)	----	sec	Used to calculate DT. The smallest ratio in the grid of a cell's minimum dimension to the sum of its maximum velocity and sound speed.
SRR	(SPHASE)	(IMAX+1,3)	$dynes/cm^2$	The normal radial stress deviator associated with cell centers. (See Section 2.3.2.2)

Variable Name	Location	Dimension of Array	Units	Definition
SRRINT	(SPHASE)	----	$dynes/cm^2$	The normal radial stress deviator of the material that will be at the center of cell K at the end of the time step.
SRZ	(SPHASE)	(IMAX+1,3)	$dynes/cm^2$	The shear stress associated with cell centers. (See Section 2.3.2.2)
SRZINT	(SPHASE)	----	$dynes/cm^2$	The shear stress of the material that will be at the center of cell K at the end of the time step.
SSIE	B.C.	(2,NMAT)	ergs/g	Temporary storage for the material specific internal energies of the two cells being combined into one in COMPRS.
SSIEN	B.C.	(NMAT)	ergs/g	Initial specific internal energy of each material package. Defined by input cards read in SETUP.
SSIGC	B.C.	(NMAT, JMAX)	ergs	The internal energy of a given material transported across the left boundary of an interface cell.
SSIGMU	SL	(NMAT)	g-cm/sec	The total change in the radial momentum of a given material in an interface cell due to transport.
SSIGMV	SL	(NMAT)	g-cm/sec	The total change in the axial momentum of a given material in an interface cell due to transport.

Variable Name	Location	Dimension of Array	Units	Definition
STAB	=Z(139)	----	----	INPUT parameter. Used in CDT. Initial value of the "stability fraction" for the calculation of DT. If FINAL = 0, STAB is constant. Otherwise, its value changes from STAB to FINAL in a geometric progression. [Note: DT = STAB*SRATIO.]
STB	(SPHASE)	(IMAX+1)	dynes/cm^2	Shear stress at bottom of cell.
STEZ	B.C.	(NMAT)	ergs/g	E_m for each material package. Used in yield-strength calculation in STRNG. Defined by input cards read by SETUP. (See Section 2.3.2.3)
STK1	B.C.	(NMAT)	dynes/cm^2	Y_1 for each material package. Used in yield-strength calculation in STRNG. Defined by input cards read by SETUP. (See Section 2.3.2.3)
STK2	B.C.	(NMAT)	dynes/cm^2	Y_2 for each material package. Used in yield-strength calculation in STRNG. Defined by input cards read by SETUP. (See Section 2.3.2.3)
STL	(SPHASE)	----	dynes/cm^2	Shear stress at left of cell.

Variable Name	Location	Dimension of Array	Units	Definition
STLX	(SPHASE)	----	dynes/cm	= STL*X(I-1) for cell in column I.
STR	(SPHASE)	----	dynes/cm^2	Shear stress at right of cell.
STRENG	(SPHASE, STRNG)	----	dynes/cm^2	The shear yield strength of cell K: $Y=(Y_0+Y_1\mu+Y_2\mu^2)(1-\frac{E_I}{E_m})$. It is calculated in subroutine STRNG and stored in WS, a blank common variable; then WS is used to define STRENG in SPHASE.
STRSRR	ELPL	(KMAX)	dynes/cm^2	The cell centered normal deviatoric stress in the radial direction.
STRSRZ	ELPL	(KMAX)	dynes/cm^2	The cell centered deviatoric shear stress.
STRSZZ	ELPL	(KMAX)	dynes/cm^2	The cell centered normal deviatoric stress in the axial direction.
STT	(SPHASE)	----	dynes/cm^2	Shear stress at top of cell.
SUME	(TPHASE)	----	ergs	Used in TPHASE to sum energy increments being ignored on a given cycle. (See SIEMIN). Used to adjust ETH, the theoretical energy total.

Variable Name	Location	Dimension of Array	Units	Definition
SYAMC	B.C.	(NMAT, JMAX)	g-cm/sec	The axial momentum of a given material transported across the left of an interface cell. (See Section 10.4.2)
SZZ	(SPHASE)	(IMAX+1,3)	dynes/cm^2	The normal axial stress deviator associated with cell centers. (See Section 2.3.2.2)
SZZINT	(SPHASE)	----	dynes/cm^2	The normal axial stress deviator of the material that will be at the center of cell k at the end of the time step.
T	=Z(84)	----	sec	Time. Initially defined in INPUT. Incremented in CDT. Adjusted in EDIT for printing and stopping at specified time values.
TABLE	=Z(1)	(1)	----	An array used by CARDS to store real variables in the Z-block of blank common.
TAU	B.C.	(IMAX)	cm^2	Initially defined in SETUP and redefined in REZONE: the area of the top face of cells in column I: $= \pi[X(I)^2-X(I-1)^2]$.
TAUDTS	(HPHASE)	----	cm^2-sec	= TAU*DT.

Variable Name	Location	Dimension of Array	Units	Definition
TFLUX	(DMADJ)	----	g	The sum of the mass transport terms for which the mass is moving out of a cell and is moving into a cell which is not flagged for evacuation. These "legitimate" transport terms are used to evacuate a material when its interface leaves a cell.
THET	B.C.	(2)	radians	Temporary storage for the angle of the slipline across the two cells being combined into one in COMPRS.
THETA	MXCELL	(NMXCLS)	radians	The angle of the slipline (with reference to the x-axis) as it crosses a slipline cell.
THO3	(SPHASE)	----	1/sec	$= 1/3\ (u_x + v_y + \frac{u}{x})$. (See Section 2.3.2.1)
TKO	(SPHASE)	----	$dynes^2/cm^4$	$= 2Y^2$, where Y is the shear yield strength of the material.
TK1	(SPHASE)	----	$dynes^2/cm^4$	Twice the second invariant of the stress deviator tensor: $S_{zz}^2 + S_{rr}^2 + S_{\theta\theta}^2 + 2S_{rz}^2$ where $S_{\theta\theta} = -(S_{rr} + S_{zz})$ is the hoop stress. Tested against TKO to see if material has yielded.

Variable Name	Location	Dimension of Array	Units	Definition
TOPM	=Z(63)	----	g	Calculated in TPHASE. Printed in EDIT. Total mass transported across top of grid.
TOPMU	=Z(9)	----	g-cm/sec	Calculated in TPHASE. Printed in EDIT. Total radial-momentum transported across top of grid.
TOPMV	=Z(66)	----	g-cm/sec	Calculated in TPHASE. Printed in EDIT. Total axial-momentum transported across top of grid.
TPX	B.C.	----	----	The distance from the left boundary of the grid to the intercept of an interface with a cell's top boundary. Converted to cell units. Used in NEWRHO as well as FRACS. (Equivalenced to WSX in FRACS.)
TPY	(FRACS)	----	----	The grid line which is the top boundary of the cell being processed by FRACS.
TRIAL	(CDT)	----	cm/sec	Used in CDT. Maximum in the grid of a cell's sound-speed plus its largest velocity component. Printed in CDT as MAXCUV.
TSTOP	=Z(50)	----	sec	INPUT parameter. Value of T at which execution stops when stopping on time rather than cycles.

Variable Name	Location	Dimension of Array	Units	Definition
TWOPI	B.C.	----	----	= 2π.
TX	B.C.	(NVOID, NTPMX)	----	X-coordinates of tracer particles circumscribing the material packages.
TXCL	B.C.	----	----	The x-coordinate (in cell units) of the top right corner of the plug package.
TX1	(FRACS)	----	----	The x-coordinate (in cell units) of the first of the pair of tracers being considered by FRACS.
TX2	(FRACS)	----	----	The x-coordinate (in cell units) of the second of the pair of tracers being considered by FRACS.
TY	B.C.	(NVOID, NTPMX)	----	Y-coordinates of tracer particles circumscribing the material packages.
TYCL	B.C.	----	----	The y-coordinate (in cell units) of the top right corner of the plug package.
TY1	(FRACS)	----	----	The y-coordinate (in cell units) of the first of the pair of tracers being considered by FRACS.
TY2	(FRACS)	----	----	The y-coordinate (in cell units) of the second of the pair of tracers being considered by FRACS.
U	B.C.	(KMAX)	cm/sec	Radial velocity of cell.
UAMMP	(TPHASE)	----	cm/sec	Radial velocity of mass transported across right cell boundary.

Variable Name	Location	Dimension of Array	Units	Definition
UAMPY	(TPHASE)	----	cm/sec	Radial velocity of mass transported across top cell boundary.
UEFF	MOV	----	cm/sec	The area-density weighted average of cell centered radial velocities used to move a given tracer particle. If a tracer is on the plug package boundary, UEFF is computed in PLUGUV.
UK	(SPHASE)	(IMAX+1,3)	cm/sec	Temporary storage for three rows of radial velocities.
UKT	(SPHASE)	----	cm/sec	Temporary storage for U(K) when computing the elastic-plastic work done by cell K.
UL	B.C.	(See definition of JDX2 parameter in Appendix A)	cm/sec	Radial velocity at left boundary of cell K. Used in HPHASE. Storage for other purposes in CDT, MAP, and TPHASE.
UMIN	=Z(129)	----	cm/sec	Calculated in CDT. Used as velocity cutoff in TPHASE, DMCALC, and MOVTCR.
UMS	(UVCALC, UVMOD)	----	cm/sec	A mass weighted average of the radial velocities of all the "master" materials in a given slipline cell.
UMSNEW	(UVCALC)	----	cm/sec	The post-HPHASE radial velocity of the "master" materials in a slipline cell. (See Section 5.2)
UNxxx	=Z(xxx)	----	----	Unused Z-storage.

Variable Name	Location	Dimension of Array	Units	Definition
URR	B.C.	----	cm/sec	The radial velocity at the right boundary of cell K, an average of the cell-centered velocities of the two cells. Used in HPHASE, DMCALC and TPHASE.
US	MXCELL	(NMAT, NMXCLS)	cm/sec	The radial velocity of a material in an interface cell. The materials in a slipline cell have different radial velocities. The cell-centered radial velocity (U) of a slipline cell is a mass-weighted average of the material radial velocities (US). (See Section 4.2)
USL	(UVCALC, UVMOD)	----	cm/sec	A mass weighted average of the radial velocities of all the "slave" materials in a given slipline cell.
USLNEW	(UVCALC)	----	cm/sec	The post-HPHASE radial velocity of the "slave" materials in a slipline cell. See Section 5.2.
USSAVE	B.C.	(2,NMAT)	cm/sec	Temporary storage for the material radial velocities of two cells being combined into one in COMPRS.
UTK	MOV	(4)	cm/sec	The radial velocity components of the four overlap cells used to compute the radial velocity of a tracer particle.
UTL	B.C.	(NMAT,JMAX)	cm/sec	The radial velocity of a given material being transported across the left boundary of a cell.

Variable Name	Location	Dimension of Array	Units	Definition
UTRANS	B.C.	(NMAT,4)	cm/sec	The radial velocity of a given material transported across one of the four boundaries of cell K (1=top, 2=bottom, 3=right, 4=left).
UUR	B.C.	(NMAT)	cm/sec	Initial radial velocity of each material package. Defined by input cards read in SETUP.
V	B.C.	(KMAX)	cm/sec	Axial velocity of cell.
VABOVE	B.C.	----	cm/sec	The axial velocity at the top boundary of cell K, an average of the cell centered velocities of the two cells. Used in HPHASE, DMCALC and TPHASE.
VALUE	(MAP)	(41)	----	Maximum value associated with each symbol printed by MAP.
VAMMP	(TPHASE)	----	cm/sec	Axial velocity of mass transported across right cell boundary.
VAMPY	(TPHASE)	----	cm/sec	Axial velocity of mass moving across top cell boundary.
VBLO	(HPHASE)	----	cm/sec	The axial velocity at the bottom boundary of cell k, an average of the cell-centered velocities of the two cells.
VCELL	(Local variable in several subroutines)	----	cm^3	The total volume of a cell. VCELL=TAU(I)*DY(J).

Variable Name	Location	Dimension of Array	Units	Definition
VCT	(DMCALC)	----	cm^3	The minimum of the volume of the donor and acceptor cells. Calculated and used in DMCALC to test if a mass transport term is too small to be counted.
VEFF	MOV	----	cm/sec	The area-density weighted average of cell-centered axial velocities used to move a given tracer particle. If a tracer is on the plug package boundary, VEFF is computed in PLUGUV.
VK	(SPHASE)	(IMAX+1,3)	cm/sec	Temporary storage for three rows of axial velocities.
VKT	(SPHASE)	----	cm/sec	Temporary storage for V(K) when computing the elastic-plastic work done by cell K.
VMS	(UVCALC, UVMOD)	----	cm/sec	A mass weighted average of the axial velocities of all the "master" materials in a given slipline cell.
VMSNEW	(UVCALC)	----	cm/sec	The post-HPHASE axial velocity of the "master" materials in a slipline cell. See Section 5.2.
VOLM	MXCELL	(NVOID, NMXCLS)	cm^3	The partial cell volume of a material in an interface cell. Computed by VOLFND to determine the mass of each material of an interface cell. Used only when generating a problem. Equivalenced to SAMMY array. (Note: this array is larger than the SAMMY array and overflows into the SGAMC array.)

Variable Name	Location	Dimension of Array	Units	Definition
VOW	(EQST)	----	----	$= \rho_o/\rho$.
VS	MXCELL	(NMAT, NMXCLS)	cm/sec	The axial velocity of a material in an interface cell. The materials in a slipline cell have different axial velocities. The cell-centered axial velocity (V) of a slipline cell is a mass-weighted average of the material axial velocities (VS). (See Section 4.2.)
VSL	(UVCALC, UVMOD)	----	cm/sec	A mass-weighted average of the axial velocities of all the "slave" materials in a given slipline cell.
VSLNEW	(UVCALC)	----	cm/sec	The post-HPHASE axial velocity of the "slave" materials in a slipline cell. See Section 5.2.
VSSAVE	B.C.	(2,NMAT)	cm/sec	Temporary storage for the material axial velocities of two cells being combined into one in COMPRS.
VSUM	(CDT, FILGRD, TPHASE)	----	cm^3	The sum of the partial volumes of the materials in an interface cell.
VTK	MOV	(4)	cm/sec	The axial velocity component of the four overlap cells used to compute the axial velocity of a tracer particle.
VTL	B.C.	(NMAT,JMAX)	cm/sec	The axial velocity of a given material being transported across the left boundary of cell K.

Variable Name	Location	Dimension of Array	Units	Definition
VTRANS	B.C.	(NMAT,4)	cm/sec	The axial velocity of a given material transported across one of the four boundaries of cell K (1=top, 2=bottom, 3=right, 4=left).
VVA	B.C.	(NMAT)	cm/sec	Initial axial velocity of each material package. Defined by input cards read by SETUP.
WF	MOV	(4)	----	The weighting factor associated with each of the four overlap cells used to compute the velocity components of a tracer particle. Used by MOVTCR and PLUGUV.
WFLAGF	=Z(51)	----	----	Used in INPUT and EDIT. Set = 1 on first cycle of a run in INPUT. Triggers an EDIT print on first cycle of every run. Reset to 0 at end of EDIT.
WFLAGL	=Z(52)	----	----	Used in HELP and EDIT. Flags last cycle. Set = 1 in EDIT. Signals HELP to call exit.
WS WSA WSB WSC WSX WSY	B.C.	----	----	Used in most subroutines for working storage.
WSMAX	(MAP)	(5)	----	The maximum value of each quantity represented by the symbolic maps.
WSMIN	(MAP)	----	----	The minimum value of each quantity represented by the symbolic maps.

Variable Name	Location	Dimension of Array	Units	Definition
WSQR	B.C.	(NMAT)	cm^5/ dynes-g	A term in the weighting factor used in the iteration to equilibrate material pressures in multi-material cells: $WSQR_i = 1/(\partial P_i/\partial V_i)_{E_i} = 1/(\rho_i^2 CSQR_i)$. (See Section 4.6.1)
WSUM	(CDT, PLGGEN, SPHASE)	----	dynes-g^2/cm^5	The sum of the weighting factors used in the pressure iteration: $WSUM = \sum M_i/WSQR_i$. (See Section 4.6.1) In PLGGEN and SPHASE WSUM is the sum of the area weighting factors.
X	B.C.	(IMAX)	cm	The distance from the left grid boundary to the right edge of a cell.
X00	B.C.	----	cm	The x-coordinate of X(0), the left grid boundary (assumed to be zero).
XAXIS	MISC	(NVOID, IMAX)	----	The x-coordinate (in cell units) of a tracer on the x-axis of the grid. If XAXIS(n,I)>0 the interface of package n has a tracer on the x-axis in column I.
XIENRG	=Z(140)	----	ergs	Total internal energy in the grid. Calculated in EDIT and used for printing labels on tracer particle plots.

Variable Name	Location	Dimension of Array	Units	Definition
XKENRG	=Z(141)	----	ergs	Total kinetic energy in the grid. Calculated in EDIT and used for printing labels on tracer particle plots.
XMAS	B.C.	(2,NMAT)	g	Temporary storage for the material masses of two cells being combined into one in COMPRS.
XMASS	MXCELL	(NMAT, NMXCLS)	g	The mass of a material in an interface cell. (See Section 4.2)
XMMS	(UVCALC, UVMOD)	----	g	The sum of the masses of the "master" materials in a slip-line cell.
XMSL	(UVCALC, UVMOD)	----	g	The sum of the masses of the "slave" materials in a slip-line cell.
XMSM	(PLGMAS)	----	g	The sum of the plug and target masses in a cell in which all the target mass is being converted to plug mass. (See Section 6.2.4)
XP	TRACRS	(NTCC)	----	X-coordinates of passive tracer particles.
XRH	B.C.	(2,NMAT)	g/cm^3	Temporary storage for the material density of two cells being combined into one in COMPRS.

Variable Name	Location	Dimension of Array	Units	Definition
XSAVE	(FRACS)	----	----	The x-coordinate (in cell units) of the previous intercept of an interface with a given cell on the x-axis. Covers the case where an interface begins and ends in the same cell on the x-axis.
XTENRG	= Z(142)	----	ergs	Total energy in the grid. Calculated in EDIT and used for printing labels on tracer particle plots.
XUM	(MAP)	(41)	----	Used in MAP. Array has negative alphabetic characters for symbolic maps. Defined in a DATA statement.
Y	B.C.	(JMAX)	cm	The distance from the bottom of the grid to top of a cell.
Y00	B.C.	----	cm	The y-coordinate of Y(0), the bottom grid boundary (assumed to be zero).
YAMC	B.C.	(JMAX)	g-cm/sec	Calculated and used in TPHASE. Axial momentum of mass transported across left side of cell. Equivalenced to UL array. (See Section 10.4.2)
YAXIS	MISC	(NVOID, JMAX)	----	The y-coordinate (in cell units) of a tracer on the y-axis of the grid. If YAXIS(n,J)>0, the interface package n has a tracer on the y-axis in column J.

Variable Name	Location	Dimension of Array	Units	Definition
YSAVE	(FRACS)	----	----	The y-coordinate (in cell units) of the previous intercept of an interface with a given cell on the y-axis. Covers the case where an interface begins and ends in the same cell on the y-axis.
Z	B.C.	(1)	----	Storage for most of the input parameters follows Z, the first word of blank common. The "Z-block" (the first 150 words of blank common) is written on a file for restarting problems.
ZMOM	B.C.	----	g-cm/sec	The total post-HPHASE axial momentum of a slipline cell. Computed in HPHASE; used in UVCALC to update the master and slave material velocities. See section 5.2.

10.4 FLAGS AND CONVENTIONS

10.4.1 Flags Governing Interface Cells

FORTRAN Statements	Meaning
RHO(1,M) = -1.0	The M location in the material arrays (XMASS, RHO, SIE, FRACTP, FRACRT, US, VS, THETAS, SAMMP, SAMPY, SAMMY, SGAMC) is not in use.
NVOID = NMAT + 1	NVOID, the number of the "void" package, is always one greater than the number of material packages.
M = MFLAG(K) - 100 RHO(NVOID,M) = 1.0	Cell K contains the free surface interface.
MFLAG(K) = 0	Cell K is empty and is not cut by an interface.
0 < MFLAG(K) < 100	Cell K is nonempty and pure; i.e., it does not contain an interface.
MFLAG(K) = 2	Cell K is completely inside the material package 2 boundary and contains only package 2 material.
MFLAG(K) > 100	Cell K is an interface cell; i.e., it contains at least one interface. M = MFLAG(K) - 100 gives location of quantities in the material arrays for cell K.
MFLAG(K) < 0	Cell K was an interface cell on the previous cycle but is no longer cut by an interface and will be reflagged at the end of TPHASE.
MAT(2) = 3	The material code number of package 2 is 3. The list in EQST indicates that code number 3 corresponds to iron.
MAT(1) = 20	The material of package 1 is an ideal gas which is given special treatment in the sound speed calculation and in the strength phase of the code.

FORTRAN Statements	Meaning
M = MFLAG(K) - 100 RHO(N,M)= 0.	The interface of package N does not cut the interface cell K. Material of package N will not be transported into cell K.
M = MFLAG(K) - 100 RHO(N,M)>0. XMASS(N,M) = 0.	The package N interface cuts the interface cell K, but cell K does not contain any material of package N. Either no material N has yet entered the cell or it has all been transported out before the package N interface has left the cell.
M = MFLAG(K) - 100 RHO(N,M) = 0. XMASS(N,M) > 0.	The package N interface has left cell K, and the material of package N [XMASS(N,M)] should be completely evacuated from cell K on this cycle.
M = MFLAG(K) - 100 THETA(M) = - 1.0	A slipline does not cross cell K, and the material velocities, (US, VS) are the same as the cell velocities, (U, V).
M = MFLAG(K) - 100 THETA(M) ≥ 0.	A slipline crosses cell K at an angle with the x-axis equal to THETA(M) radians. The material velocities (US, VS) of the master and slave packages will not (in general) be equal, and the cell velocities (U, V) will be a mass-weighted average of the material velocities. See Chapter V.

10.4.2 Definition of Transport Variables

In HELP there are four transported quantities: mass, radial momentum, axial momentum and total energy (or internal energy in the case of interface cells). There are sixteen variables which store these four quantities for the four boundaries of a cell; these variables are indicated in the Figure 10.2. The direction of the arrows indicates the direction of flow for which the variables are positive. Negative values of these variables indicate the flow is opposite to the direction of the arrows.

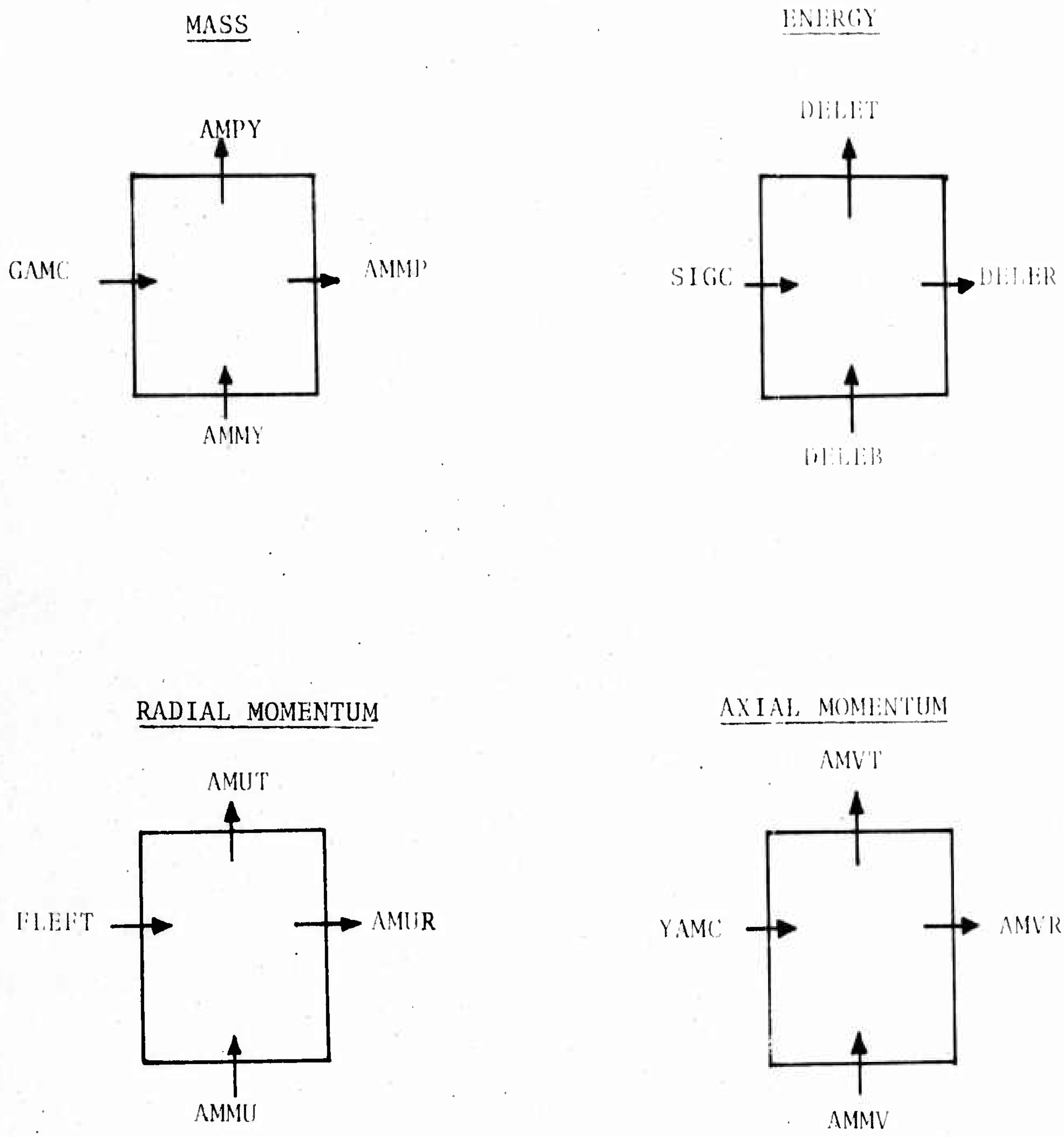


Figure 10.2--The sixteen variables which store the transported quantities between pure cells.

The variables given in Figure 10.2 are cell variables, and are used to compute the effects of transport for a pure cell. An interface cell, on the otherhand, must have each of these transport quantitites defined for each material package. The material transport variables were named by preceding the corresponding cell transport variable names with an "S". For example, the mass of package 2 transported across the top of cell K is stored in SAMPY (2, m), whereas the total mass transported across the top of cell K is stored in AMPY. Furthermore, the cell variables of interface cells are defined by summing the material variables. For example, for an interface cell

$$AMPY = \sum_n SAMPY(n,m)$$

where m = MFLAG(K) - 100. Only the interface cell energy variables do not exactly correspond to the pure cell variables. For example, DELET is the total energy transported across the top of cell K and SDELET (n,m) is the internal energy of package n transported across the top of the cell. Therefore,

$$DELET = \sum_n SDELET(n,m) + \frac{1}{2} \sum_n [SAMPY(n,m) \cdot (ud_n^2 + vd_n^2)]$$

where ud_n and vd_n are the donor cell material n velocity components. The energy variables at the other boundaries are defined in a like manner.

10.4.3 Radial and Axial Terms

Both x and r are used interchangeably in the FORTRAN variable names in the code and in the notation of this report to denote the radial direction. For example, the radial dimensions of the cells are stored in the DX array, but are printed out under the heading "DR". The following equation

for a strain rate deviator (from Section 2.3.2.1 of this report) also shows this mixture of x and r notation:

$$\dot{\varepsilon}_{rr} = u_x - \frac{1}{3}(u_x + v_y + \frac{u}{x}) \quad .$$

In the axial direction y and z are likewise used interchangeably.

CHAPTER XI

SAMPLE HELP INPUT AND OUTPUT

The HELP input and output will be illustrated in this chapter by considering three representative calculations:

1. Shaped Charge Liner Collapse
2. Perforation of a Thin Target
3. Impact into a Thick Target.

The input cards for these problems will be listed, and the distinctive aspects of each problem will be discussed. The output resulting from cycle 0 of each calculation will also be presented, as well as configuration plots* showing the material interfaces and the calculational grid. Some important aspects of the HELP output will be discussed in Section 11.4.

11.1 SHAPED CHARGE LINER COLLAPSE

The shaped charge calculation presented here will illustrate the use of sliplines and high explosive detonation. The calculation consists of three material packages and a void (NMAT = 3): package one is a copper liner; package two is a charge of Comp B, which is detonated at a point on the axis of symmetry; package three is an aluminum casing; and package four is the void. (The void package number is always NMAT + 1.)

Figure 11.1 shows the initial configuration of the problem, and Figure 11.2 shows the initial zoning of the grid relative to the dimensions of the material packages. For this problem the finest zoning was chosen to be in the region of the grid where the high explosive detonates and where the jet forms since it is important to resolve the detonation front and the stagnation region behind the jet.

*Because of the axis of symmetry in these calculations, only the right half of each figure is actually in the computational grid.

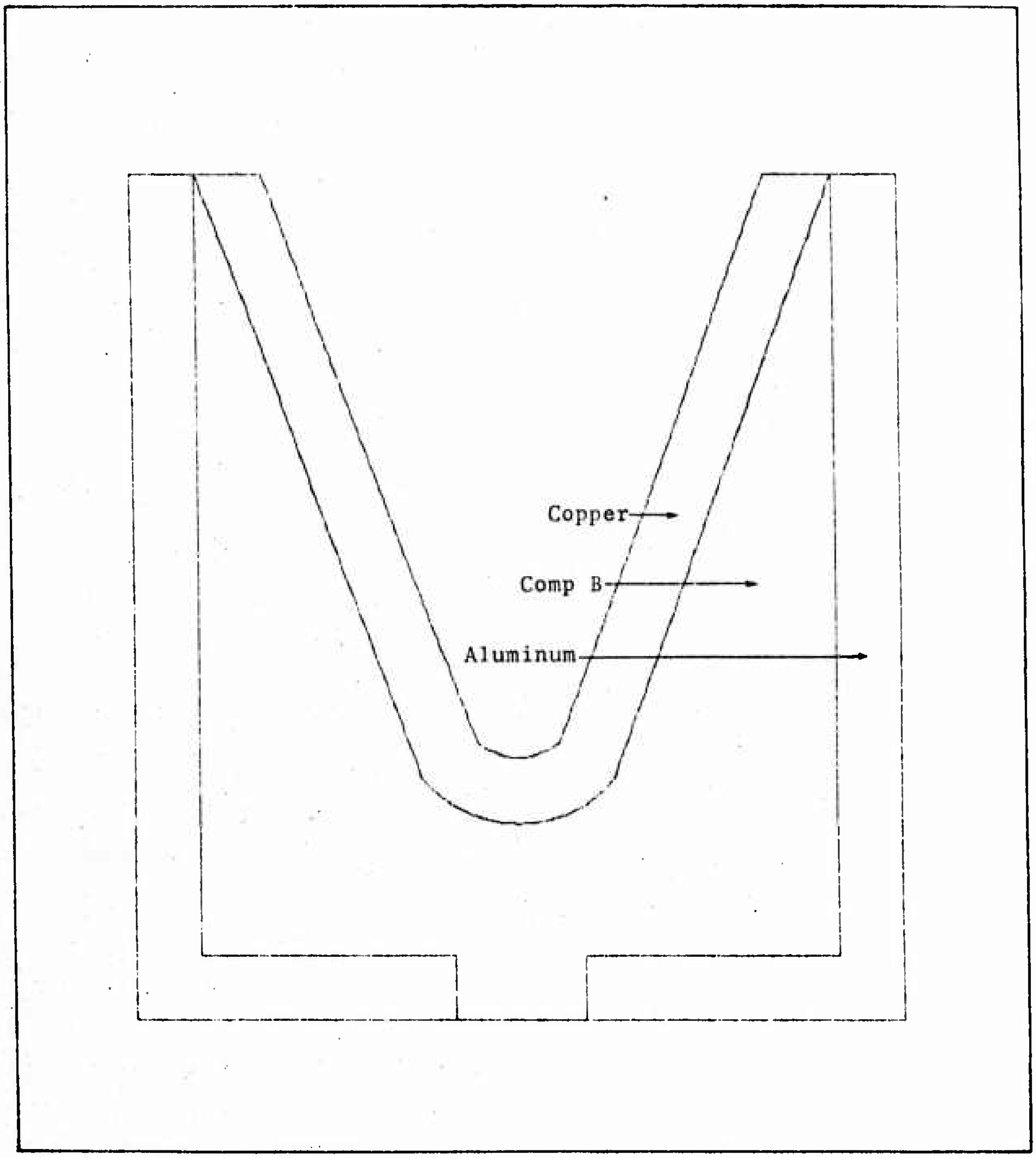


Figure 11.1--Initial configuration of the shaped charge liner collapse calculation.

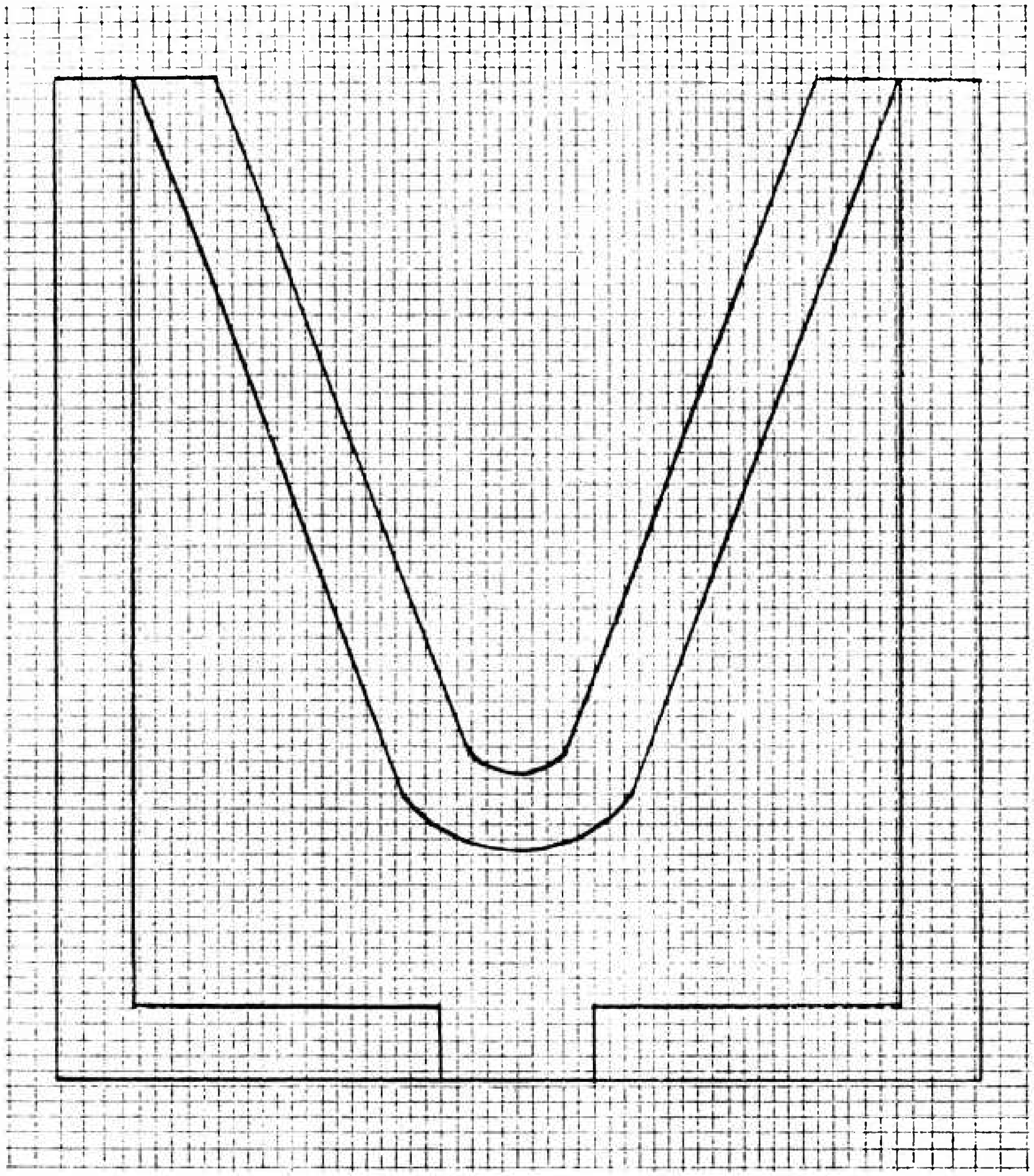


Figure 11.2-- Initial zoning of the grid relative to the dimensions of the liner, explosive and casing in the shaped charge liner collapse calculation.

The coarest zoning is to the right of the casing since this region is not of great interest in the solution.

Since this is a shaped charge calculation, the variable NLINER is set to 1, the liner package number. The value of the variable NOSLIP remains 0, its default value, indicating that the slipline option will be used. All of the interfaces between the explosive and the metal are designated as sliplines since it is assumed that the expanded detonation products do actually "slip" on the metal surfaces. Both the liner and casing are defined to be "master" packages; the explosive is defined to be a "slave" package. (As discussed in Chapter V, the symmetry of the equations governing the motion of "master" and "slave" packages makes the designation of packages as "master" or "slave" an arbitrary one.)

Since tremendous distortions are expected for the material in the slug and jet portions of the liner, the variables NADD, MINX, MAXX, MINY, and MAXY are defined so that every ten cycles (NADD = 10) ADDTCR checks tracer spacing in that region and adds tracers when necessary.

Because of the geometry of the liner and the high explosive, only the portion of the explosive package which is shaded in Figure 11.3 can be "seen" by the primary initiation point (see Section 7.2.7). Thus it is necessary to define a secondary initiation point, denoted by ⊗ on the figure, to calculate detonation times for the unshaded part of the explosive.

If the calculation is to be carried to late times after the jet has formed, the user may want to rezone the grid in the axial direction to keep the jet tip within the calculational grid. This must be decided at the time the problem is generated since in order to rezone the grid, JMAX (the number of rows in the grid) must be an even

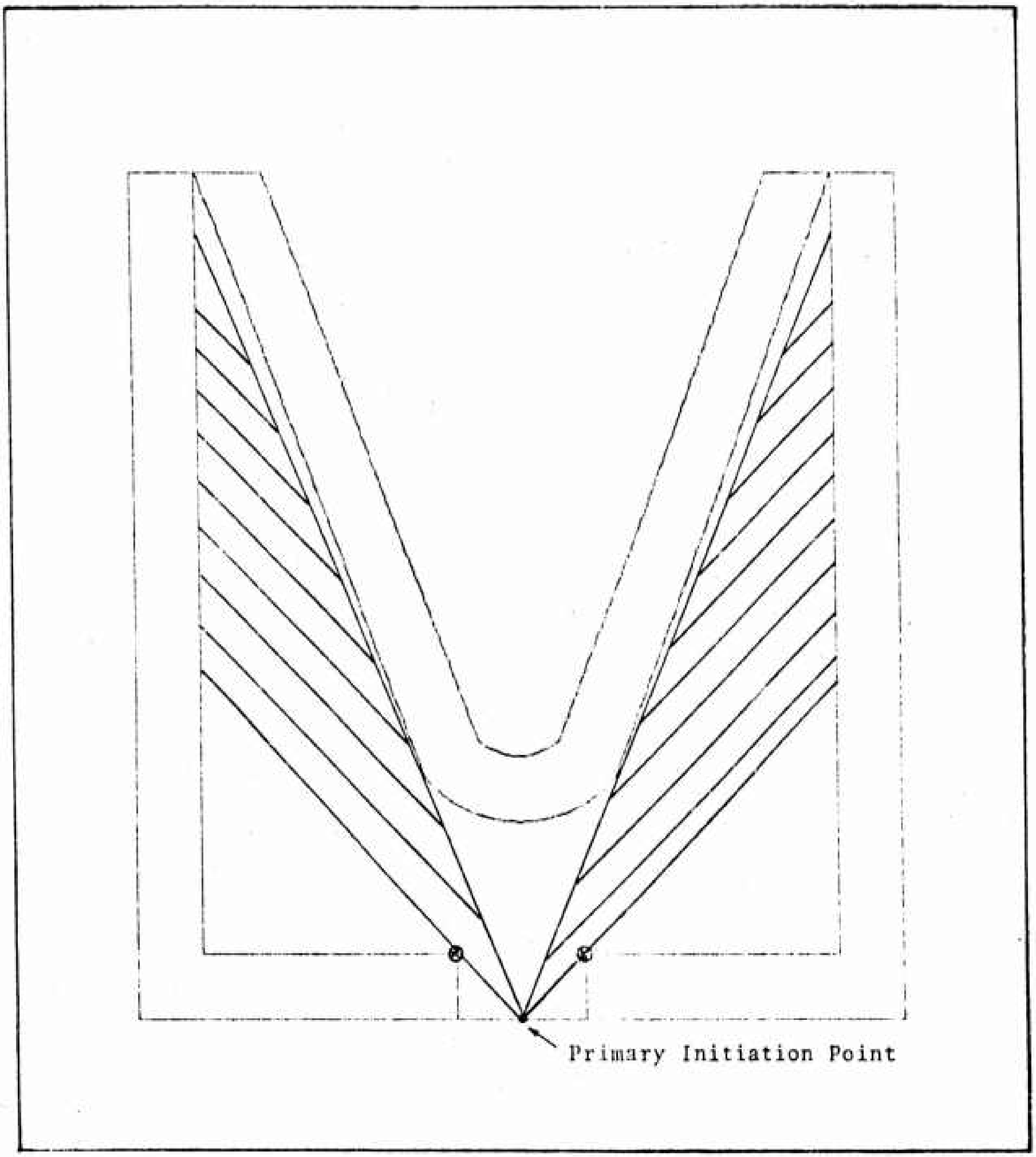


Figure 11.3--The area "seen" by the primary initiation point is shaded. The secondary initiation points are denoted by ⊗.

number. Then, later in the calculation, just before the jet tip enters the top row of the grid, the calculation must be stopped and the rezone flags (REZ and JEXTY) set in the restart deck so that the grid will be rezoned on the restart cycle. The rezoned grid will have less resolution in the axial direction, but it will have JMAX/2 more void cells into which the jet can expand. This of course, is possible only if the problem is generated so that the jet moves toward the top rather than the bottom grid boundary. (See Section 8.1 for more details on rezoning procedures. In particular, see Section 8.1.2 for the reason the jet tip cannot be allowed to enter top row of grid before the grid is rezoned.)

The input cards for the shaped charge problem are listed on the following pages along with the cycle 0 output.

11.1.1 Input

```
 2-6   8-16                                                                Column Indicator
1234567890123456789012345678901234567890123456789012345678901234567890123456789C

                SHAPED  CHARGE  LINER  COLLAPSE                          Heading Card
```

1	2-6	7	8-16	
1	151	1	5.0	PK(1)
	1	1	5.0	PROB
2	5	1	10.	NFRELP
2	6	1	1.	NDUMP7
2	7	1	100.	ICSTOP
2	12	1	1.	NUMREZ
	27	1	-1.	CVIS
2	33	1	34.	IMAX
2	35	1	86.	JMAX
2	42	1	1.	MAPS
2	47	1	3.	I1
2	48	1	11.	I2
2	49	1	25.	IPCYCL
2	66	1	3.	NMAT
2	72	1	2.	NTRACR
2	73	1	430.	NMXCLS
2	78	1	350.	NTPMX
2	105	1	1.	NLINER
2	112	1	200.	NSLD
2	118	1	10.	NADD
2	119	1	1.	MINX
2	120	1	10.	MAXX
2	121	1	18.	MINY
2	122	1	86.	MAXY
2	124	1	1.	JEXTY
1	50	1	0.	TSTOP

```
                                                                   Column Indicator
     1-10        11-20       21-30       31-40       40-41       51-60
1234567890|1234567890|1234567890|1234567890|1234567890|1234567890|1234567890|1234567890|

        25    1    1    1   .100       .110       .121       .133         DX
         1    1    1    1   .146       .161       .177       .195
         1    1  999          .214       .243

         1    1    1    1   .161       .146       .133       .121         DY
         1   61  999         .110       .100

         0                                                                MFLAG(2)
         2       8.9        0.         0.         0.                      MAT,ρ,E_I,U,V
        21       1.717      0.         0.         0.
         4       2.79       0.         0.         0.

2.35      +396.95   +105.5    +105.3    +094.55   +11.9785               Y_o,Y_1,Y_2,E_m,G,AMDM
0.          0.         0.        0.        0.        1.0
3.0       +090.        0.        7.0    +092.74   +11.985
```

Column Indicator

```
1-5 |6-10|11-15|16-20|21-30    |31-40    |
1234567890123456789012345678901234567890123456789012345678901234567890123456789012345678890

    4    1   15
3.14159   2.30405
0.        3.5       1.0
    3    1   90
.743      2.84327   2.5356    7.5
    1    1    6
2.5356    7.5       2.0       7.5
    3    1   90
2.0       7.5       .3157     3.1123
   -4    1    8
2.45824   3.14159
0.        3.5       .5
```

Material Tracers for Package 1 (Liner)

```
    1    2   15
0.        1.0       .5        1.0
    2    2   10
.5        1.0       .5        1.5
    1    2   30
.5        1.5       2.5356    1.5
    2    2   90
2.5356    1.5       2.5356    7.5
    3    2   90
2.5356    7.5       .743      2.84327
   -4    2   15
2.30405   3.14159
0.        3.5       1.0
```

Material Tracers for Package 2 (Explosive)

```
   11    3   40
.5        1.0       3.0356    1.0
   21    3  100
3.0356    1.0       3.0356    7.5
    1    3    5
3.0356    7.5       2.5356    7.5
    2    3   90
2.5356    7.5       2.5356    1.5
    1    3   30
2.5356    1.5       .5        1.5
   -2    3   10
.5        1.5       .5        1.0
```

Material Tracers for Package 3 (Casing)

```
    4    4    4
3.14159   2.45824
0.        3.5       .5
    3    4   90
.3157     3.1123    2.0       7.5
    1    4    6
2.0       7.5       2.5356    7.5
    1    4    5
2.5356    7.5       3.0356    7.5
    2    4  100
3.0356    7.5       3.0356    1.0
    1    4   40
3.0356    1.0       .5        1.0
   -1    4   15
.5        1.0       0.        1.0
```

Material Tracers for Package 4 (Void)

```
  100
```

End of Material Tracer Data

```
    1-10       11-20     21-30     31-40     41-50
1234567890|1234567890|1234567890|1234567890|1234567890|1234567890123456789012345678 90
                                                                      Column Indicator

    1    0    1    0   105    0          ]  Slipline Endpoints
    0    2    0   16     0  250          ]
    3    0  146    0   275    0          ]

         1         2    0.         1.6        0.    ]  Detonation Points
         2         2    .5         1.5        0.    ]  End of Detonation Points
         0

0.          1.0      .5         2.7       ]  Area for each
.5          1.5     2.6         7.5       ]  Detonation Point

1  15010.                                    End of Input
```

11.1.2 Cycle 0 Output

```
                         SHAPED  CHARGE  LINER  COLLAPSE

   INPUT CARDS


1    151  1    5.000000+00

   INPUT CARDS


0       1  1    5.000000+00
2       5  1    1.000000+01
2       6  1    1.000000+00
2       7  1    1.000000+02
2      12  1    1.000000+00
0      27  1   -1.000000+00
2      33  1    3.400000+01
2      36  1    8.600000+01
2      42  1    1.000000+00
2      47  1    3.000000+00
2      48  1    1.100000+01
2      49  1    2.500000+01
2      68  1    3.000000+00
2      72  1    2.000000+00
2      73  1    4.000000+02
2      78  1    3.500000+02
2     105  1    1.000000+00
2     112  1    2.000000+02
2     118  1    1.200000+01
2     119  1    1.000000+00
2     120  1    1.000000+01
2     121  1    1.800000+01
2     122  1    8.600000+01
2     124  1    1.000000+00
1      50  1    0.000000
  TYPE=    4      PACKAGE=   1     NUMBER OF POINTS=   15
THI=    .3141590+01  TH2=     .2304050+01  A=    .0000000      B=    .3500000+01  R=    .1000000+01
  TYPE=    3      PACKAGE=   1     NUMBER OF POINTS=   90
  XI=    .7430000+00      YI=    .2830700+01     X2=    .2535600+01      Y2=    .7500000+01
  TYPE=    1      PACKAGE=   1     NUMBER OF POINTS=    6
  XI=    .2535600+01      YI=    .7500000+01     X2=    .2000000+01      Y2=    .7500000+01
  TYPE=    3      PACKAGE=   1     NUMBER OF POINTS=   90
  XI=    .2000000+01      YI=    .7500000+01     X2=    .3157000+00      Y2=    .3112300+01
  TYPE=   -4      PACKAGE=   1     NUMBER OF POINTS=    8
THI=    .2458240+01  TH2=     .3141590+01  A=    .0000000      B=    .3500000+01  R=    .5000000+00
  TYPE=    1      PACKAGE=   2     NUMBER OF POINTS=   15
```

```
    X1=    .0000000        Y1=     .1000000+01    X2=    .5000000+00     Y2=    .1000000+01
    TYPE=   2      PACKAGE=  2     NUMBER OF POINTS=  10
    X1=    .5000000+00     Y1=     .1000000+01    X2=    .5000000+00     Y2=    .1500000+01
    TYPE=   1      PACKAGE=  2     NUMBER OF POINTS=  30
    X1=    .5000000+00     Y1=     .1500000+01    X2=    .2535600+01     Y2=    .1500000+01
    TYPE=   2      PACKAGE=  2     NUMBER OF POINTS=  90
    X1=    .2535600+01     Y1=     .1500000+01    X2=    .2535600+01     Y2=    .7500000+01
    TYPE=   3      PACKAGE=  2     NUMBER OF POINTS=  90
    X1     2535600 01      Y1      .7500000 01    X2     7430000 00      Y2     2830700 01
    TYPE=  -4      PACKAGE=  2     NUMBER OF POINTS=  15
 TH1=    .2304050+01   TH2=    .3141590+01   A=    .0000000    B=    .3500000+01   R=    .1000000+01
    TYPE=   1      PACKAGE=  3     NUMBER OF POINTS=  40
    X1=    .5000000+00     Y1=     .1000000+01    X2=    .3035600+01     Y2=    .1000000+01
    TYPE=   2      PACKAGE=  3     NUMBER OF POINTS= 100
    X1=    .3035600+01     Y1=     .1000000+01    X2=    .3035600+01     Y2=    .7500000+01
    TYPE=   1      PACKAGE=  3     NUMBER OF POINTS=   5
    X1=    .3035600+01     Y1=     .7500000+01    X2=    .2535600+01     Y2=    .7500000+01
    TYPE=   2      PACKAGE=  3     NUMBER OF POINTS=  90
    X1=    .2535600+01     Y1=     .7500000+01    X2=    .2535600+01     Y2=    .1500000+01
    TYPE=   1      PACKAGE=  3     NUMBER OF POINTS=  30
    X1=    .2535600+01     Y1=     .1500000+01    X2=    .5000000+00     Y2=    .1500000+01
    TYPE=  -2      PACKAGE=  3     NUMBER OF POINTS=  10
    X1=    .5000000+00     Y1=     .1500000+01    X2=    .5000000+00     Y2=    .1000000+01
    TYPE=   4      PACKAGE=  4     NUMBER OF POINTS=   8
 TH1=    .3141590+01   TH2=    .2458240+01   A=    .0000000    B=    .3500000+01   R=    .5000000+00
    TYPE=   3      PACKAGE=  4     NUMBER OF POINTS=  90
    X1=    .3157000+00     Y1=     .3112300+01    X2=    .2000000+01     Y2=    .7500000+01
    TYPE=   1      PACKAGE=  4     NUMBER OF POINTS=   6
    X1=    .2000000+01     Y1=     .7500000+01    X2=    .2535600+01     Y2=    .7500000+01
    TYPE=   1      PACKAGE=  4     NUMBER OF POINTS=   5
    X1=    .2535600+01     Y1=     .7500000+01    X2=    .3035600+01     Y2=    .0000000
    TYPE=   2      PACKAGE=  4     NUMBER OF POINTS= 100
    X1=    .3035600+01     Y1=     .7500000+01    X2=    .3035600+01     Y2=    .1000000+01
    TYPE=   :      PACKAGE=  4     NUMBER OF POINTS=  40
    X1=    .3035600+01     Y1=     .1000000+01    X2=    .5000000+00     Y2=    .1000000+01
    TYPE=  -1      PACKAGE=  4     NUMBER OF POINTS=  15
    X1=    .5000000+00     Y1=     .1000000+01    X2=    .0000000        Y2=    .1000000+01
    TYPE= 100      PACKAGE=  0     NUMBER OF POINTS=   0
```

DEFINITION OF SLIDE ENDPOINTS

PKG. NO.	MASTER	SLAVE	NBGM	NBGS	NENDM	NENDS
1	1	0	1	0	105	0
2	0	2	0	16	0	250
3	3	0	146	0	275	0

DETONATION TIME CALCULATION FOR EXPLOSIVE PACKAGES

```
TYPE OF INITIATION POINT   1   EXPLOSIVE PACKAGE   2   INITIATION POINTS  0.00000       1.00000+00  DELAY TIME  0.00000
TYPE OF INITIATION POINT   2   EXPLOSIVE PACKAGE   2   INITIATION POINTS  5.00000-01    1.50000+00  DELAY TIME  0.00000
```

```
SEARCH AREA XMIN    0.0000000     YMIN    1.0000000+00   XMAX    5.0000000-01   YMAX    2.7000000+00
INITIATION POINT X      0.0000000      Y        1.0000000+00   DELAY TIME    0.0000000

               DETONATION TIME FOR EACH ROW(J)

   J

   9 .6795861-07 .1898031-06 .3143865-06 .4393852-06 .5645235-06 .0000000    .0000000    .0000000    .0000000    .0000000
     .0000000    .0000000    .0000000    .0000000    .0000000    .0000000    .0000000    .0000000    .0000000    .0000000
     .0000000    .0000000    .0000000    .0000000    .0000000    .0000000    .0000000    .0000000    .0000000    .0000000
     .0000000    .0000000    .0000000    .0000000
  10 .1643647-06 .2415037-06 .3480485-06 .4640671-06 .5839397-06 .0000000    .0000000    .0000000    .0000000    .0000000
     .0000000    .0000000    .0000000    .0000000    .0000000    .0000000    .0000000    .0000000    .0000000    .0000000
     .0000000    .0000000    .0000000    .0000000    .0000000    .0000000    .0000000    .0000000    .0000000    .0000000
     .0000000    .0000000    .0000000    .0000000
  11 .2639417-06 .3347084-06 .4181428-06 .5187137-06 .6282446-06 .0000000    .0000000    .0000000    .0000000    .0000000
     .0000000    .0000000    .0000000    .0000000    .0000000    .0000000    .0000000    .0000000    .0000000    .0000000
     .0000000    .0000000    .0000000    .0000000    .0000000    .0000000    .0000000    .0000000    .0000000    .0000000
     .0000000    .0000000    .0000000    .0000000
  12 .4071061-06 .4440070-06 .5098587-06 .5951272-06 .6926787-06 .0000000    .0000000    .0000000    .0000000    .0000000
     .0000000    .0000000    .0000000    .0000000    .0000000    .0000000    .0000000    .0000000    .0000000    .0000000
     .0000000    .0000000    .0000000    .0000000    .0000000    .0000000    .0000000    .0000000    .0000000    .0000000
     .0000000    .0000000    .0000000    .0000000
  13 .5312765-06 .5600550-06 .6135758-06 .6860727-06 .7722196-06 .0000000    .0000000    .0000000    .0000000    .0000000
     .0000000    .0000000    .0000000    .0000000    .0000000    .0000000    .0000000    .0000000    .0000000    .0000000
     .0000000    .0000000    .0000000    .0000000    .0000000    .0000000    .0000000    .0000000    .0000000    .0000000
     .0000000    .0000000    .0000000    .0000000
  14 .6558818-06 .6794025-06 .7241557-06 .7865252-06 .8626988-06 .9493595-06 .0000000    .0000000    .0000000    .0000000
     .0000000    .0000000    .0000000    .0000000    .0000000    .0000000    .0000000    .0000000    .0000000    .0000000
     .0000000    .0000000    .0000000    .0000000    .0000000    .0000000    .0000000    .0000000    .0000000    .0000000
     .0000000    .0000000    .0000000    .0000000
  15 .7807137-06 .8005753-06 .8388888-06 .8932832-06 .9610319-06 .1039527-05 .0000000    .0000000    .0000000    .0000000
     .0000000    .0000000    .0000000    .0000000    .0000000    .0000000    .0000000    .0000000    .0000000    .0000000
     .0000000    .0000000    .0000000    .0000000    .0000000    .0000000    .0000000    .0000000    .0000000    .0000000
     .0000000    .0000000    .0000000    .0000000
  16 .9056786-06 .9228546-06 .9562815-06 .1004338-05 .1065046-05 .1136379-05 .0000000    .0000000    .0000000    .0000000
     .0000000    .0000000    .0000000    .0000000    .0000000    .0000000    .0000000    .0000000    .0000000    .0000000
     .0000000    .0000000    .0000000    .0000000    .0000000    .0000000    .0000000    .0000000    .0000000    .0000000
     .0000000    .0000000    .0000000    .0000000
  17 .1030728-05 .1045852-05 .1075463-05 .1118410-05 .1173230-05 .1238347-05 .0000000    .0000000    .0000000    .0000000
     .0000000    .0000000    .0000000    .0000000    .0000000    .0000000    .0000000    .0000000    .0000000    .0000000
     .0000000    .0000000    .0000000    .0000000    .0000000    .0000000    .0000000    .0000000    .0000000    .0000000
     .0000000    .0000000    .0000000    .0000000
  18 [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] .0000000    .0000000    .0000000    .0000000
     .0000000    .0000000    .0000000    .0000000    .0000000    .0000000    .0000000    .0000000    .0000000    .0000000
     .0000000    .0000000    .0000000    .0000000    .0000000    .0000000    .0000000    .0000000    .0000000    .0000000
     .0000000    .0000000    .0000000    .0000000
  19 .1280982-05 .1293183-05 .1317245-05 .1352537-05 .1398207-05 .1453278-05 .0000000    .0000000    .0000000    .0000000
     .0000000    .0000000    .0000000    .0000000    .0000000    .0000000    .0000000    .0000000    .0000000    .0000000
     .0000000    .0000000    .0000000    .0000000    .0000000    .0000000    .0000000    .0000000    .0000000    .0000000
     .0000000    .0000000    .0000000    .0000000
  20 .1406158-05 .1417282-05 .1439271-05 .1471639-05 .1513720-05 .1564731-05 .0000000    .0000000    .0000000    .0000000
     .0000000    .0000000    .0000000    .0000000    .0000000    .0000000    .0000000    .0000000    .0000000    .0000000
     .0000000    .0000000    .0000000    .0000000    .0000000    .0000000    .0000000    .0000000    .0000000    .0000000
```

	.0000000	.0000000	.0000000	.0000000						
21	.1531357-05	.1541578-05	.1561818-05	.1591696-05	.1630682-05	.1678141-05	.0000000	.0000000	.0000000	.0000000
	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000
	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000
	.0000000	.0000000	.0000000	.0000000						
22	.1656574-05	.1666026-05	.1684772-05	.1712506-05	.1748801-05	.1793137-05	.0000000	.0000000	.0000000	.0000000
	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000
	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000
	.0000000	.0000000	.0000000	.0000000						
23	.1781803-05	.1798595-05	.1808050-05	.1833921-05	.1867858-05	.1909431-05	.0000000	.0000000	.0000000	.0000000
	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000
	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000
	.0000000	.0000000	.0000000	.0000000						
24	.1907044-05	.1915261-05	.1931570-05	.1955827-05	.1987684-05	.2026801-05	.0000000	.0000000	.0000000	.0000000
	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000
	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000
	.0000000	.0000000	.0000000	.0000000						
25	.0000000	.0000000	.0000000	.2078139-05	.2108148-05	.2145069-05	.0000000	.0000000	.0000000	.0000000
	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000
	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000
	.0000000	.0000000	.0000000	.0000000						
26	.0000000	.0000000	.0000000	.0000000	.0000000	.2264096-05	.0000000	.0000000	.0000000	.0000000
	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000
	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000
	.0000000	.0000000	.0000000	.0000000						

SEARCH AREA XMIN 5.0000000-01 YMIN 1.5000000+00 XMAX 2.6000000+00 YMAX 7.5000000+00
INITIATION POINT X 5.0000000-01 Y 1.5000000+00 DELAY TIME 8.8609870-07

DETONATION TIME FOR EACH ROW(J)

J										
9	.6795861-07	.1898031-06	.3143865-06	.4393852-06	.5645235-06	.0000000	.0000000	.0000000	.0000000	.0000000
	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000
	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000
	.0000000	.0000000	.0000000	.0000000						
10	.1640647-06	.2415037-06	.3480485-06	.4640671-06	.5839397-06	.0000000	.0000000	.0000000	.0000000	.0000000
	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000
	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000
	.0000000	.0000000	.0000000	.0000000						
11	.2839417-06	.3347084-06	.4181428-06	.5187137-06	.6282446-06	.0000000	.0000000	.0000000	.0000000	.0000000
	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000
	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000
	.0000000	.0000000	.0000000	.0000000						
12	.4071061-06	.4440070-06	.5098587-06	.5951272-06	.6926787-06	.0000000	.0000000	.0000000	.0000000	.0000000
	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000
	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000
	.0000000	.0000000	.0000000	.0000000						
13	.5312765-06	.5600550-06	.6135758-06	.6860727-06	.7722196-06	.0000000	.0000000	.0000000	.0000000	.0000000
	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000
	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000
	.0000000	.0000000	.0000000	.0000000						
14	.6558818-06	.6794025-06	.7241557-06	.7865252-06	.8626988-06	.9493595-06	.1075902-05	.1200485-05	.1326484-05	.1450622-05
	.1575824-05	.1701060-05	.1826317-05	.1951586-05	.2076865-05	.2202151-05	.2327441-05	.2452736-05	.2578032-05	.2703332-05
	.2828633-05	.2953935-05	.3079239-05	.3204543-05	.3329849-05	.3461421-05	.0000000	.0000000	.0000000	.0000000
	.0000000	.0000000	.0000000	.0000000						
15	.7807137-06	.8005753-06	.8388868-06	.8932832-06	.9610319-06	.1039527-05	.1127602-05	.1234147-05	.1350166-05	.1470038-05
	.1591804-05	.1714628-05	.1838101-05	.1962000-05	.2086192-05	.2210596-05	.2335156-05	.2459836-05	.2584609-05	.2709457-05
	.2834364-05	.2959320-05	.3084317-05	.3209347-05	.3334407-05	.3465746-05	.0000000	.0000000	.0000000	.0000000
	.0000000	.0000000	.0000000	.0000000						
16	.9056786-06	.9228546-06	.9562815-06	.1004338-05	.1065046-05	.1136379-05	.1220807-05	.1304241-05	.1404812-05	.1514343-05
	.1628881-05	.1746428-05	.1865902-05	.1986675-05	.2108363-05	.2230717-05	.2353570-05	.2476808-05	.2600346-05	.2724125-05
	.2848098-05	.2972232-05	.3096498-05	.3220877-05	.3345351-05	.3476135-05	.0000000	.0000000	.0000000	.0000000
	.0000000	.0000000	.0000000	.0000000						
17	.1030728-05	.1045652-05	.1075463-05	.1118410-05	.1173230-05	.1238347-05	.1330106-05	.1395957-05	.1481226-05	.1578777-05
	.1684120-05	.1794547-05	.1908413-05	.2024686-05	.2142698-05	.2262002-05	.2382289-05	.2503340-05	.2624994-05	.2747134-05
	.2869670-05	.2992533-05	.3115668-05	.3239034-05	.3362595-05	.3492514-05	.0000000	.0000000	.0000000	.0000000
	.0000000	.0000000	.0000000	.0000000						
18	.1155835-05	.1169342-05	.1195899-05	.1234664-05	.1284532-05	.1344268-05	.1446154-05	.1499674-05	.1572171-05	.1658318-05
	.1754060-05	.1856562-05	.1963895-05	.2074754-05	.2188236-05	.2303713-05	.2420734-05	.2538971-05	.2658181-05	.2778180-05
	.2898827-05	.3020011-05	.3141647-05	.3263665-05	.3386009-05	.3514771-05	.0000000	.0000000	.0000000	.0000000
	.0000000	.0000000	.0000000	.0000000						
19	.1280982-05	.1293183-05	.1317245-05	.1352537-05	.1398207-05	.1453278-05	.1565501-05	.1610254-05	.1672624-05	.1748797-05
	.1835458-05	.1929997-05	.2030464-05	.2135429-05	.2243850-05	.2354961-05	.2468196-05	.2583129-05	.2699439-05	.2816875-05
	.2935245-05	.3054395-05	.3174204-05	.3294573-05	.3415422-05	.3542759-05	.0000000	.0000000	.0000000	.0000000
	.0000000	.0000000	.0000000	.0000000						
20	.1406158-05	.1417282-05	.1439271-05	.1471639-05	.1513720-05	.1564731-05	.1686674-05	.1724987-05	.1779382-05	.1847131-05
	.1925626-05	.2012623-05	.2106306-05	.2205250-05	.2308358-05	.2414788-05	.2523891-05	.2635169-05	.2748231-05	.2862770-05
	.2978545-05	.3095362-05	.3213062-05	.3331519-05	.3450628-05	.3576299-05	.0000000	.0000000	.0000000	.0000000

	.0000000	.0000000	.0000000	.0000000						
21	.1531357-05	.1541578-05	.1561818-05	.1591696-05	.1630682-05	.1678141-05	.1808953-05	.1842380-05	.1890437-05	.1951144-05
	.2022477-05	.2102568-05	.2189803-05	.2282845-05	.2380609-05	.2482228-05	.2587011-05	.2694409-05	.2803982-05	.2915377-05
	.3028311-05	.3142552-05	.3257912-05	.3374235-05	.3491392-05	.3615186-05	.0000000	.0000000	.0000000	.0000000
	.0000000	.0000000	.0000000	.0000000						
22	.1656574-05	.1666026-05	.1684772-05	.1712506-05	.1748801-05	.1793137-05	.1931951-05	.1961562-05	.2004509-05	.2059329-05
	.2124445-05	.2198327-05	.2279580-05	.2366992-05	.2459537-05	.2556361-05	.2656763-05	.2760167-05	.2866104-05	.2974188-05
	.3084102-05	.3195585-05	.3308421-05	.3422428-05	.3537456-05	.3659195-05	.0000000	.0000000	.0000000	.0000000
	.0000000	.0000000	.0000000	.0000000						
23	.1781803-05	.1790595-05	.1808050-05	.1833921-05	.1867858-05	.1909431-05	.2055441-05	.2081998-05	.2120762-05	.2170631-05
	.2230367-05	.2298719-05	.2374502-05	.2456640-05	.2544188-05	.2636336-05	.2732393-05	.2831783-05	.2934018-05	.3038695-05
	.3145473-05	.3254069-05	.3364243-05	.3475794-05	.3588552-05	.3708087-05	.0000000	.0000000	.0000000	.0000000
	.0000000	.0000000	.0000000	.0000000						
24	.1907044-05	.1915261-05	.1931590-05	.1955827-05	.1987684-05	.2026801-05	.2179281-05	.2203344-05	.2238635-05	.2284305-05
	.2339377-05	.2402825-05	.2473646-05	.2550899-05	.2633732-05	.2721389-05	.2813212-05	.2908633-05	.3007168-05	.3108402-05
	.3211982-05	.3317609-05	.3425027-05	.3534019-05	.3644397-05	.3761612-05	.0000000	.0000000	.0000000	.0000000
	.0000000	.0000000	.0000000	.0000000						
25	.0000000	.0000000	.0000000	.2078139-05	.2108148-05	.2145069-05	.2303381-05	.2325370-05	.2357738-05	.2399819-05
	.2450830-05	.2509929-05	.2576268-05	.2649030-05	.2727454-05	.2810847-05	.2898593-05	.2990146-05	.3085031-05	.3182835-05
	.3283201-05	.3385821-05	.3490427-05	.3596790-05	.3704712-05	.3819518-05	.0000000	.0000000	.0000000	.0000000
	.0000000	.0000000	.0000000	.0000000						
26	.0000000	.0000000	.0000000	.0000000	.0000000	.2264096-05	.8427676-05	.2447917-05	.2477795-05	.2516781-05
	.2544240-05	.2619477-05	.2681773-05	.2750422-05	.2824748-05	.2904125-05	.2987980-05	.3075799-05	.3167124-05	.3261551-05
	.335[illegible]	[illegible]	.3560103-05	.3663800-05	.3769214-05	.3881548-05	.0000000	.0000000	.0000000	.0000000
	.0000000	.0000000	.0000000	.0000000						
27	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.2552125-05	.2570871-05	.2598605-05	.2634900-05
	.2679235-05	.2731032-05	.2789681-05	.2854571-05	.2925104-05	.3000717-05	.3080885-05	.3165127-05	.3253008-05	.3344137-05
	.3438168-05	.3534790-05	.3633730-05	[illegible]748-05	.383762[illegible]-05	.394[illegible]55-05	.0000000	.0000000	.0000000	.0000000
	.0000000	.0000000	.0000000	.0000000						
28	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.2694149-05	.2720019-05	.2753956-05
	.2[illegible]552[illegible]-05	.2[illegible]44253-05	.2[illegible]60-05	.2[illegible]61061-05	.302[illegible]0[illegible]1-05	.310017[illegible]0-05	.31[illegible]6[illegible]-05	.325[illegible]13-05	.3342274-05	.343021[illegible]-05
	.3521178-05	.3614863-05	.3711000-05	.3809349-05	.3909693-05	.4016991-05	.0000000	.0000000	.0000000	.0000000
	.0000000	.0000000	.0000000	.0000000						
29	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.2817688-05	.2841926-05	.2873782-05
	.2912899-05	.2958865-05	.3011236-05	.3069551-05	.3133347-05	.3202172-05	.3275590-05	.3353192-05	.3434596-05	.3519449-05
	.3607429-05	.3698241-05	.3791622-05	.3887329-05	.3985150-05	.4089922-05	.0000000	.0000000	.0000000	.0000000
	.0000000	.0000000	.0000000	.0000000						
30	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.2964237-05	.2994247-05
	.3031168-05	.3074651-05	.3124315-05	.3179756-05	.3240568-05	.3306345-05	.3376695-05	.3451240-05	.3529627-05	.3611523-05
	.3696621-05	.3784641-05	.3875323-05	.3968433-05	.4063758-05	.4166020-05	.0000000	.0000000	.0000000	.0000000
	.0000000	.0000000	.0000000	.0000000						
31	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.3086887-05	.3115246-05
	.3150194-05	.3191434-05	.3238633-05	.3291441-05	.3349498-05	.3412440-05	.3479914-05	.3551574-05	.3627093-05	.3706160-05
	.3788485-05	.3873800-05	.3961854-05	.4052421-05	.4145290-05	.4245071-05	.0000000	.0000000	.0000000	.0000000
	.0000000	.0000000	.0000000	.0000000						
32	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.3236696-05
	.3269866-05	.3309069-05	.3354020-05	.3404409-05	.3459919-05	.3520229-05	.3585004-05	.3653945-05	.3728744-05	.3803111-05
	.3882774-05	.3965477-05	.4050982-05	.4139068-05	.4229531-05	.4326870-05	.0000000	.0000000	.0000000	.0000000
	.0000000	.0000000	.0000000	.0000000						
33	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.3358533-05
	.3390089-05	.3427438-05	.3470331-05	.3518495-05	.3571647-05	.3629498-05	.3691756-05	.3758136-05	.3828357-05	.3902153-05
	.3979266-05	.4059455-05	.4142494-05	.4228169-05	.4316283-05	.4411227-05	.0000000	.0000000	.0000000	.0000000
	.0000000	.0000000	.0000000	.0000000						
34	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.3480701-05

	.3510788-05	.3546444-05	.3587447-05	.3633559-05	.3684527-05	.3740090-05	.3799987-05	.3863954-05	.3931737-05	.4003086-05
	.4077761-05	.4155536-05	.4236194-05	.4319531-05	.4405358-05	.4497962-05	.0000000	.0000000	.0000000	.0000000
	.0000000	.0000000	.0000000	.0000000						
35	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000
	.3631901-05	.3666034-05	.3705269-05	.3749484-05	.3798423-05	.3851854-05	.3909537-05	.3971234-05	.4036710-05	.4105733-05
	.4178081-05	.4253539-05	.4331904-05	.4412980-05	.4496587-05	.4586909-05	.0000000	.0000000	.0000000	.0000000
	.0000000	.0000000	.0000000	.0000000						
36	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000
	.3753375-05	.3786049-05	.3823710-05	.3866168-05	.3913222-05	.3964661-05	.4020269-05	.4079827-05	.4143121-05	.4209935-05
	.4280062-05	.4353302-05	.4429461-05	.4508355-05	.4589808-05	.4677910-05	.0000000	.0000000	.0000000	.0000000
	.0000000	.0000000	.0000000	.0000000						
37	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000
	.0000000	.3906523-05	.3942700-05	.3983528-05	.4028824-05	.4078401-05	.4132061-05	.4189605-05	.4250834-05	.4315550-05
	.4383560-05	.4454676-05	.4528716-05	.4605505-05	.4684877-05	.4770823-05	.0000000	.0000000	.0000000	.0000000
	.0000000	.0000000	.0000000	.0000000						
38	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000
	.0000000	.4027375-05	.4062176-05	.4101487-05	.4145145-05	.4192978-05	.4244808-05	.4300452-05	.4359727-05	.4422451-05
	.4488444-05	.4557529-05	.4629536-05	.4704297-05	.4781657-05	.4865513-05	.0000000	.0000000	.0000000	.0000000
	.0000000	.0000000	.0000000	.0000000						
39	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000
	.0000000	.4104526-05	.4182086-05	.4219983-05	.4262109-05	.4308307-05	.4358416-05	.4412268-05	.4469694-05	.4530526-05
	.4594597-05	.4661740-05	.4731795-05	.4804607-05	.4880023-05	.4961856-05	.0000000	.0000000	.0000000	.0000000
	.0000000	.0000000	.0000000	.0000000						
40	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000
	.0000000	.0000000	.4302383-05	.4338960-05	.4379652-05	.4424316-05	.4472804-05	.4524964-05	.4580639-05	.4639674-05
	.4701911-05	.4767199-05	.4835384-05	.4906319-05	.4979863-05	.5059739-05	.0000000	.0000000	.0000000	.0000000
	.0000000	.0000000	.0000000	.0000000						
41	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000
	.0000000	.0000000	.4423029-05	.4458371-05	.4497718-05	.4540939-05	.4587900-05	.4638460-05	.4692475-05	.4749802-05
	.4810293-05	.4873606-05	.4940199-05	.5009332-05	.5081069-05	.5159054-05	.0000000	.0000000	.0000000	.0000000
	.0000000	.0000000	.0000000	.0000000						
42	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000
	.0000000	.0000000	.4500433-05	.4578173-05	.4616256-05	.4658120-05	.4703639-05	.4752686-05	.4805127-05	.4860829-05
	.4919656-05	.4981473-05	.5046148-05	.5113549-05	.5183547-05	.5259705-05	.0000000	.0000000	.0000000	.0000000
	.0000000	.0000000	.0000000	.0000000						
43	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000
	.0000000	.0000000	.0000000	.4698329-05	.4735223-05	.4775807-05	.4819965-05	.4867579-05	.4918527-05	.4972683-05
	.5029922-05	.5090119-05	.5153147-05	.5218883-05	.5287207-05	.5361601-05	.0000000	.0000000	.0000000	.0000000
	.0000000	.0000000	.0000000	.0000000						
44	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000
	.0000000	.0000000	.0000000	.4818807-05	.4854582-05	.4893957-05	.4936827-05	.4983084-05	.5032612-05	.5085297-05
	.5141022-05	.5199668-05	.5261118-05	.5325256-05	.5391967-05	.5464659-05	.0000000	.0000000	.0000000	.0000000
	.0000000	.0000000	.0000000	.0000000						
45	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000
	.0000000	.0000000	.0000000	.0000000	.4974297-05	.5012529-05	.5054181-05	.5099148-05	.5147328-05	.5198612-05
	.5252891-05	.5310054-05	.5369992-05	.5432594-05	.5497753-05	.5568803-05	.0000000	.0000000	.0000000	.0000000
	.0000000	.0000000	.0000000	.0000000						
46	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000
	.0000000	.0000000	.0000000	.0000000	.5094337-05	.5131489-05	.5171984-05	.5215729-05	.5262625-05	.5312574-05
	.5365472-05	.5421216-05	.5479704-05	.5540831-05	.5604495-05	.5673962-05	.0000000	.0000000	.0000000	.0000000
	.0000000	.0000000	.0000000	.0000000						
47	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000
	.0000000	.0000000	.0000000	.0000000	.5172452-05	.5250805-05	.5290203-05	.5332784-05	.5378459-05	.5427134-05
	.5478712-05	.5533099-05	.5590195-05	.5649905-05	.5712130-05	.5780069-05	.0000000	.0000000	.0000000	.0000000

	.0000000	.0000000	.0000000	.0000000						
48	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	[illegible]
	.0000000	.0000000	.0000000	.0000000	.0000000	.5370447-05	.5408803-05	.5450279-05	.5494789-05	.5542247-05
	.5592565-05	.5645650-05	.5701413-05	.5759760-05	.5820600-05	.5887065-05	.0000000	.0000000	.0000000	.0000000
	.0000000	.0000000	.0000000	.0000000						
49	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000
	.0000000	.0000000	.0000000	.0000000	.0000000	.5490391-05	.5527757-05	.5568178-05	.5611578-05	.5657875-05
	.5706986-05	.5758825-05	.5813307-05	.5870344-05	[illegible]	[illegible]	.0000000	.0000000	.0000000	.0000000
	.0000000	.0000000	.0000000	.0000000						
50	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000
	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.5647036-05	.5686453-05	.5728793-05	.5773981-05
	.5821936-05	.5872581-05	.5925832-05	.5981610-05	.6039833-05	.6103506-05	.0000000	.0000000	.0000000	.0000000
	.0000000	.0000000	.0000000	.0000000						
51	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000
	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.5766618-05	.5805077-05	.5846405-05	.5890530-05
	.5937379-05	.5986877-05	.6038949-05	.6093515-05	.6150499-05	.6212850-05	.0000000	.0000000	.0000000	.0000000
	.0000000	.0000000	.0000000	.0000000						
52	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000
	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.5845235-05	.5924025-05	.5964385-05	.6007493-05
	.6053283-05	.6101681-05	.6152617-05	.6206017-05	.6261809-05	.6322884-05	.0000000	.0000000	.0000000	.0000000
	.0000000	.0000000	.0000000	.0000000						
53	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000
	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.6043274-05	.6082708-05	.6124843-05
	.6169615-05	.6216957-05	.6266802-05	.6319081-05	.6373723-05	.6433566-05	.0000000	.0000000	.0000000	.0000000
	.0000000	.0000000	.0000000	.0000000						
54	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000
	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.6162804-05	.6201351-05	.6242553-05
	.6286350-05	.6332677-05	.6381473-05	.6432670-05	.6486205-05	.6544857-05	.0000000	.0000000	.0000000	.0000000
	.0000000	.0000000	.0000000	.0000000						
55	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000
	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.6241477-05	.6320294-05	.6360601-05
	.6403460-05	.6448813-05	.6496598-05	.6546755-05	.6599220-05	.6656725-05	.0000000	.0000000	.0000000	.0000000
	.0000000	.0000000	.0000000	.0000000						
56	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000
	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.6439518-05	.6478965-05
	.6520924-05	.6565339-05	.6612152-05	.6661305-05	.6712739-05	.6769134-05	.0000000	.0000000	.0000000	.0000000
	.0000000	.0000000	.0000000	.0000000						
57	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000
	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.655[illegible]003-05	.65[illegible]625-05
	.6638719-05	.6682231-05	.6728108-05	.6776293-05	.6826732-05	.6882055-05	.0000000	.0000000	.0000000	.0000000
	.0000000	.0000000	.0000000	.0000000						
58	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000
	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.6716564-05
	.6756825-05	.6799469-05	.6844443-05	.6891695-05	.6941172-05	.6995459-05	.0000000	.0000000	.0000000	.0000000
	.0000000	.0000000	.0000000	.0000000						
59	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000
	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.6835765-05
	.6875225-05	.6917030-05	.6961135-05	.7007485-05	.7056035-05	.7109320-05	.0000000	.0000000	.0000000	.0000000
	.0000000	.0000000	.0000000	.0000000						
60	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000
	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.6914780-05
	.6993900-05	.7034899-05	.7078163-05	.7123645-05	.7171297-05	.7223612-05	.0000000	.0000000	.0000000	.0000000
	.0000000	.0000000	.0000000	.0000000						
61	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000

	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000
	.7112835-05	.7153057-05	.7195510-05	.7240152-05	.7286737-05	.7338315-05	.0000000	.0000000	.0000000	.0000000
	.0000000	.0000000	.0000000	.0000000						
62	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000
	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000
	.7232016-05	.7271487-05	.7313158-05	.7356988-05	.7402734-05	.7453405-05	.0000000	.0000000	.0000000	.0000000
	.0000000	.0000000	.0000000	.0000000						
63	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000
	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000
	.0000000	.7390174-05	.7431090-05	.7474137-05	.7519271-05	.7568863-05	.0000000	.0000000	.0000000	.0000000
	.0000000	.0000000	.0000000	.0000000						
64	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000
	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000
	.0000000	.7509106-05	.7549292-05	.7591579-05	.7635929-05	.7684670-05	.0000000	.0000000	.0000000	.0000000
	.0000000	.0000000	.0000000	.0000000						
65	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000
	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000
	.0000000	.7588391-05	.7667750-05	.7709303-05	.7752892-05	.7800809-05	.0000000	.0000000	.0000000	.0000000
	.0000000	.0000000	.0000000	.0000000						
66	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000
	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000
	.0000000	.0000000	.7786449-05	.7827291-05	.7870144-05	.7917262-05	.0000000	.0000000	.0000000	.0000000
	.0000000	.0000000	.0000000	.0000000						
67	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000
	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000
	.0000000	.0000000	.7905378-05	.7945533-05	.7987672-05	.8034015-05	.0000000	.0000000	.0000000	.0000000
	.0000000	.0000000	.0000000	.0000000						
68	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000
	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000
	.0000000	.0000000	.7984666-05	.8064014-05	.8105462-05	.8151054-05	.0000000	.0000000	.0000000	.0000000
	.0000000	.0000000	.0000000	.0000000						
69	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000
	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000
	.0000000	.0000000	.0000000	.8182724-05	.8223501-05	.8268364-05	.0000000	.0000000	.0000000	.0000000
	.0000000	.0000000	.0000000	.0000000						
70	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000
	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000
	.0000000	.0000000	.0000000	.8301651-05	.8341777-05	.8385933-05	.0000000	.0000000	.0000000	.0000000
	.0000000	.0000000	.0000000	.0000000						
71	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000
	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000
	.0000000	.0000000	.0000000	.0000000	.8460279-05	.8503749-05	.0000000	.0000000	.0000000	.0000000
	.0000000	.0000000	.0000000	.0000000						
72	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000
	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000
	.0000000	.0000000	.0000000	.0000000	.8578998-05	.8621800-05	.0000000	.0000000	.0000000	.0000000
	.0000000	.0000000	.0000000	.0000000						
73	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000
	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000
	.0000000	.0000000	.0000000	.0000000	.8658491-05	.8740076-05	.0000000	.0000000	.0000000	.0000000
	.0000000	.0000000	.0000000	.0000000						
74	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000
	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000	.0000000
	.0000000	.0000000	.0000000	.0000000	.0000000	.8858568-05	.0000000	.0000000	.0000000	.0000000

.0000000 .0000000 .0000000 .0000000

INPUT CARDS

1 150 1 0.000000

ICSTOP	IDLT	IDRT	IEXTX	IGM	IMAX	INTER	IPCYCL	IPLGBT	IPLGRT
100	1	26	0	0	34	0	25	0	0
IPLGTP	**IPR**	**I1**	**I2**	**JDBT**	**JDTP**	**JEXTY**	**JMAX**	**KUNITR**	**KUNITW**
0	35	3	11	9	74	1	86	7	7
LVISC	**MAPS**	**MAXX**	**MAXY**	**MINX**	**MINY**	**NADD**	**NDUMP7**	**NFRELP**	**NLINER**
0	1	10	86	1	18	10	1	10	1
NMAT	**NMXCLS**	**NODUMP**	**NOSLIP**	**NSLD**	**NTCC**	**NTPMX**	**NTRACR**	**NUMSCA**	**NUMREZ**
3	400	0	0	200	0	350	2	0	1
NVRTEX									
0									

BBAR	CRATIO	CVIS	CYCMX	CYCPH3	DMIN	DTMIN	EMIN	FINAL
5.0000-01	1.0000+04	-1.0000+00	2.0000+00	1.0000+00	1.0000-03	1.0000-11	1.0000+07	4.0000-01
GAMMA	**PLGOPT**	**PLWMIN**	**PMIN**	**PRCNT**	**PRDELT**	**PRFACT**	**PRLIM**	**PROB**
0.0000	0.0000	0.0000	5.0000+06	1.0000-03	0.0000	0.0000	0.0000	5.0000+00
REZ	**ROEPS**	**SIEMIN**	**STAB**	**TSTOP**				
0.0000	1.0000-05	1.0000+05	1.0000-03	0.0000				

I N I T I A L C O N D I T I O N S

PACKAGE NUMBER	NORMAL DENSITY (RHOZ)	DENSITY (RHOIN)	S.I.E.	U	V	MATERIAL
1	8.900	8.900	0.0000	0.0000	0.0000	COPPER
2	1.717	1.717	0.0000	0.0000	0.0000	COMP B
3	2.790	2.790	0.0000	0.0000	0.0000	ALUMINUM

S T R E N G T H C O N S T A N T S

PACKAGE NUMBER	CZERO	STK1	STK2	STEZ	RMU	AMDM
1	2.350+09	6.950+10	5.500+10	8.300+09	4.550+11	9.785-01
2	0.000	0.000	0.000	0.000	0.000	1.000+00
3	3.000+09	0.000	0.000	9.000+09	2.740+11	9.850-01

I	DR	I	DR	I	DR	I	DR	I	DR	I	DR	I	DR
1	1.000-01	2	1.000-01	3	1.000-01	4	1.000-01	5	1.000-01	6	1.000-01	7	1.000-01
8	1.000-01	9	1.000-01	10	1.000-01	11	1.000-01	12	1.000-01	13	1.000-01	14	1.000-01
15	1.000-01	16	1.000-01	17	1.000-01	18	1.000-01	19	1.000-01	20	1.000-01	21	1.000-01
22	1.000-01	23	1.000-01	24	1.000-01	25	1.000-01	26	1.100-01	27	1.210-01	28	1.330-01

29	1.460-01	30	1.610-01	31	1.770-01	32	1.950-01	33	2.140-01	34	2.430-01

I	R	I	R	I	R	I	R	I	R	I	R	I	R
1	1.000-01	2	2.800-01	3	3.000-01	4	4.000-01	5	5.000-01	6	6.000-01	7	7.000-01
8	8.000-01	9	9.000-01	10	1.000+00	11	1.100+00	12	1.200+00	13	1.300+00	14	1.400+00
15	1.500+00	16	1.600+00	17	1.700+00	18	1.800+00	19	1.900+00	20	2.000+00	21	2.100+00
22	2.200+00	23	2.300+00	24	2.400+00	25	2.500+00	26	2.610+00	27	2.731+00	28	2.864+00
29	3.010+00	30	3.171+00	31	3.348+00	32	3.543+00	33	3.757+00	34	4.000+00		

J	DZ	J	DZ	J	DZ	J	DZ	J	DZ	J	DZ	J	DZ
1	1.610-01	2	1.460-01	3	1.330-01	4	1.210-01	5	1.100-01	6	1.000-01	7	1.000-01
8	1.000-01	9	1.000-01	10	1.000-01	11	1.000-01	12	1.000-01	13	1.000-01	14	1.000-01
15	1.000-01	16	1.000-01	17	1.000-01	18	1.000-01	19	1.000-01	20	1.000-01	21	1.000-01
22	1.000-01	23	1.000-01	24	1.000-01	25	1.000-01	26	1.000-01	27	1.000-01	28	1.000-01
29	1.000-01	30	1.000-01	31	1.000-01	32	1.000-01	33	1.000-01	34	1.000-01	35	1.000-01
36	1.000-01	37	1.000-01	38	1.000-01	39	1.000-01	40	1.000-01	41	1.000-01	42	1.000-01
43	1.000-01	44	1.000-01	45	1.000-01	46	1.000-01	47	1.000-01	48	1.000-01	49	1.000-01
50	1.000-01	51	1.000-01	52	1.000-01	53	1.000-01	54	1.000-01	55	1.000-01	56	1.000-01
57	1.000-01	58	1.000-01	59	1.000-01	60	1.000-01	61	1.000-01	62	1.000-01	63	1.000-01
64	1.000-01	65	1.000-01	66	1.000-01	67	1.000-01	68	1.000-01	69	1.000-01	70	1.000-01
71	1.000-01	72	1.000-01	73	1.000-01	74	1.000-01	75	1.000-01	76	1.000-01	77	1.000-01
78	1.000-01	79	1.000-01	80	1.000-01	81	1.000-01	82	1.000-01	83	1.000-01	84	1.000-01
85	1.000-01	86	1.000-01										

J	Z	J	Z	J	Z	J	Z	J	Z	J	Z	J	Z
1	1.610-01	2	3.070-01	3	4.400-01	4	5.610-01	5	6.710-01	6	7.710-01	7	8.710-01
8	9.710-01	9	1.071+00	10	1.171+00	11	1.271+00	12	1.371+00	13	1.471+00	14	1.571+00
15	1.671+00	16	1.771+00	17	1.871+00	18	1.971+00	19	2.071+00	20	2.171+00	21	2.271+00
22	2.371+00	23	2.471+00	24	2.571+00	25	2.671+00	26	2.771+00	27	2.871+00	28	2.971+00
29	3.071+00	30	3.171+00	31	3.271+00	32	3.371+00	33	3.471+00	34	3.571+00	35	3.671+00
36	3.771+00	37	3.871+00	38	3.971+00	39	4.071+00	40	4.171+00	41	4.271+00	42	4.371+00
43	4.471+00	44	4.571+00	45	4.671+00	46	4.771+00	47	4.871+00	48	4.971+00	49	5.071+00
50	5.171+00	51	5.271+00	52	5.371+00	53	5.471+00	54	5.571+00	55	5.671+00	56	5.771+00
57	5.871+00	58	5.971+00	59	6.071+00	60	6.171+00	61	6.271+00	62	6.371+00	63	6.471+00
64	6.571+00	65	6.671+00	66	6.771+00	67	6.871+00	68	6.971+00	69	7.071+00	70	7.171+00
71	7.271+00	72	7.371+00	73	7.471+00	74	7.571+00	75	7.671+00	76	7.771+00	77	7.871+00
78	7.971+00	79	8.071+00	80	8.171+00	81	8.271+00	82	8.371+00	83	8.471+00	84	8.571+00
85	8.671+00	86	8.771+00										

CYCLE 0

.1895761+09ERGS HAS BEEN ADDED DUE TO DETONATION OF THESE CELLS:

1 9

CDT 1 9 T= 6.7958614-08 DT= 7.3821364-10 MAXCUV= 2.7092428+05 MAXUV= 0.0000000 UMIN= 2.7092428+00 PMIN= 5.0000000+06

PROBLEM	TIME	CYCLE	TOT.EN.THEOR.	MAX.REL.ERROR-CYCLE		IE SET TO ZERO-PH2	ELASTIC PLASTIC WORK
5.0000	6.7958614-08	0	1.8957610+08	0.0000000	0	0.0000000	0.0000000

PACKAGE NO.	IE	KE	TOT.EN. (SUM)	MASS	MV	MV(POSITIVE)	MU	PLASTIC-WO
1	0.0000000	0.0000000	0.0000000	1.9488310+02	0.0000000	0.0000000	0.0000000	0.0000000
2	1.8957610+08	0.0000000	1.8957610+08	1.3380233+02	0.0000000	0.0000000	0.0000000	0.0000000
3	0.0000000	0.0000000	0.0000000	1.8578395+02	0.0000000	0.0000000	0.0000000	0.0000000
	------------	------------	------------	------------	------------	------------	------------	------------
TOTALS	1.8957610+08	0.0000000	1.8957610+08	5.1446937+02	0.0000000	0.0000000	0.0000000	0.0000000

	IE OUT	KE OUT
1	0.0000000	0.0000000
2	0.0000000	0.0000000
3	0.0000000	0.0000000

BOUNDARY	BOTTOM	RIGHT	TOP	SEVAPORATEDS
MASS OUT	0.0000000	0.0000000	0.0000000	0.0000000
ENERGY OUT	0.0000000	0 0000000	0.0000000	0 0000000
MU OUT	0.0000000	0.0000000	0.0000000	0.0000000
MV OUT	0.0000000	0.0000000	0.0000000	0.0000000
WORK DONE	0.0000000	0.0000000	0.0000000	

DEFINITION OF SLIDE ENDPOINTS

PKG. NO.	MASTER	SLAVE	NBGM	NBGS	NENDM	NENDS
1	1	0	1	0	105	0
2	0	2	0	16	0	250
3	3	0	146	0	275	0

CELL-COORDINATES OF TRACERS FOR EACH MATERIAL PACKAGE

PACKAGE 1

N	X	Y	N	X	Y	N	X	Y	N	X	Y	N	X	Y
1	.00	23.29	2	.60	23.31	3	1.19	23.36	4	1.79	23.45	5	2.37	23.57
6	2.95	23.73	7	3.51	23.93	8	4.07	24.15	9	4.61	24.41	10	5.13	24.70
11	5.63	25.03	12	6.12	25.38	13	6.58	25.76	14	7.02	26.16	15	7.43	26.60
16	7.43	26.60	17	7.63	27.12	18	7.83	27.65	19	8.03	28.17	20	8.24	28.70
21	8.44	29.22	22	8.64	29.74	23	8.84	30.27	24	9.04	30.79	25	9.24	31.32
26	9.44	31.84	27	9.65	32.37	28	9.85	32.89	29	10.05	33.42	30	10.25	33.94
31	10.45	34.47	32	10.65	34.99	33	10.85	35.52	34	11.06	36.04	35	11.26	36.57
36	11.46	37.09	37	11.66	37.61	38	11.86	38.14	39	12.06	38.66	40	12.26	39.19
41	12.47	39.71	42	12.67	40.24	43	12.87	40.76	44	13.07	41.29	45	13.27	41.81
46	13.47	42.34	47	13.67	42.86	48	13.88	43.39	49	14.08	43.91	50	14.28	44.43
51	14.48	44.96	52	14.68	45.48	53	14.88	46.01	54	15.08	46.53	55	15.29	47.06
56	15.49	47.58	57	15.69	48.11	58	15.89	48.63	59	16.09	49.16	60	16.29	49.68

61	16.49	50.21	62	16.70	50.73	63	16.90	51.26	64	17.10	51.78	65	17.30	52.30
66	17.50	52.83	67	17.70	53.35	68	17.90	53.88	69	18.11	54.40	70	18.31	54.93
71	18.51	55.45	72	18.71	55.98	73	18.91	56.50	74	19.11	57.03	75	19.31	57.55
76	19.51	58.08	77	19.72	58.60	78	19.92	59.12	79	20.12	59.65	80	20.32	60.17
81	20.52	60.70	82	20.72	61.22	83	20.92	61.75	84	21.13	62.27	85	21.33	62.80
86	21.53	63.32	87	21.73	63.85	88	21.93	64.37	89	22.13	64.90	90	22.33	65.42
91	22.54	65.95	92	22.74	66.47	93	22.94	66.99	94	23.14	67.52	95	23.34	68.04
96	23.54	68.57	97	23.74	69.09	98	23.95	69.62	99	24.15	70.14	100	24.35	70.67
101	24.55	71.19	102	24.75	71.72	103	24.95	72.24	104	25.14	72.77	105	25.32	73.29
106	25.32	73.29	107	24.28	73.29	108	23.21	73.29	109	22.14	73.29	110	21.07	73.29
111	20.00	73.29	112	20.00	73.29	113	19.81	72.80	114	19.62	72.30	115	19.43	71.81
116	19.24	71.32	117	19.05	70.83	118	18.86	70.33	119	18.68	69.84	120	18.49	69.35
121	18.30	68.85	122	18.11	68.36	123	17.92	67.87	124	17.73	67.37	125	17.54	66.88
126	17.35	66.39	127	17.16	65.90	128	16.97	65.40	129	16.78	64.91	130	16.59	64.42
131	16.40	63.92	132	16.22	63.43	133	16.03	62.94	134	15.84	62.44	135	15.65	61.95
136	15.46	61.46	137	15.27	60.97	138	15.08	60.47	139	14.89	59.98	140	14.70	59.49
141	14.51	58.99	142	14.32	58.50	143	14.13	58.01	144	13.94	57.51	145	13.75	57.02
146	13.57	56.53	147	13.38	56.04	148	13.19	55.54	149	13.00	55.05	150	12.81	54.56
151	12.62	54.06	152	12.43	53.57	153	12.24	53.08	154	12.05	52.58	155	11.86	52.09
156	11.67	51.60	157	11.48	51.11	158	11.29	50.61	159	11.11	50.12	160	10.92	49.63
161	10.73	49.13	162	10.54	48.64	163	10.35	48.15	164	10.16	47.65	165	9.97	47.16
166	9.78	46.67	167	9.59	46.18	168	9.40	45.68	169	9.21	45.19	170	9.02	44.70
171	8.83	44.20	172	8.65	43.71	173	8.46	43.22	174	8.27	42.72	175	8.08	42.23
176	7.89	41.74	177	7.70	41.25	178	7.51	40.75	179	7.32	40.26	180	7.13	39.77
181	6.94	39.27	182	6.75	38.78	183	6.56	38.29	184	6.37	37.79	185	6.18	37.30
186	6.00	36.81	187	5.81	36.32	188	5.62	35.82	189	5.43	35.33	190	5.24	34.84
191	5.05	34.34	192	4.86	33.85	193	4.67	33.36	194	4.48	32.86	195	4.29	32.37
196	4.10	31.88	197	3.91	31.39	198	3.72	30.89	199	3.54	30.40	200	3.35	29.91
201	3.16	29.41	202	3.16	29.41	203	2.76	29.12	204	2.34	28.87	205	1.90	28.67
206	1.44	28.50	207	.97	28.39	208	.49	28.31	209	.00	28.29	210	-1000.00	.00

PACKAGE 2

N	X	Y	N	X	Y	N	X	Y	N	X	Y	N	X	Y
1	.00	8.29	2	.36	8.29	3	.71	8.29	4	1.07	8.29	5	1.43	8.29
6	1.79	8.29	7	2.14	8.29	8	2.50	8.29	9	2.86	8.29	10	3.21	8.29
11	3.57	8.29	12	3.93	8.29	13	4.29	8.29	14	4.64	8.29	15	5.00	8.29
16	5.00	8.29	17	5.00	8.85	18	5.00	9.40	19	5.00	9.96	20	5.00	10.51
21	5.00	11.07	22	5.00	11.62	23	5.00	12.18	24	5.00	12.73	25	5.00	13.29
26	5.00	13.29	27	5.70	13.29	28	6.40	13.29	29	7.11	13.29	30	7.81	13.29
31	8.51	13.29	32	9.21	13.29	33	9.91	13.29	34	10.62	13.29	35	11.32	13.29
36	12.02	13.29	37	12.72	13.29	38	13.42	13.29	39	14.13	13.29	40	14.83	13.29
41	15.53	13.29	42	16.23	13.29	43	16.93	13.29	44	17.63	13.29	45	18.34	13.29
46	19.04	13.29	47	19.74	13.29	48	20.44	13.29	49	21.14	13.29	50	21.85	13.29
51	22.55	13.29	52	23.25	13.29	53	23.95	13.29	54	24.65	13.29	55	25.32	13.29
56	25.32	13.29	57	25.32	13.96	58	25.32	14.64	59	25.32	15.31	60	25.32	15.99
61	25.32	16.66	62	25.32	17.33	63	25.32	18.01	64	25.32	18.68	65	25.32	19.36
66	25.32	20.03	67	25.32	20.71	68	25.32	21.38	69	25.32	22.05	70	25.32	22.73
71	25.32	23.40	72	25.32	24.08	73	25.32	24.75	74	25.32	25.42	75	25.32	26.10
76	25.32	26.77	77	25.32	27.45	78	25.32	28.12	79	25.32	28.80	80	25.32	29.47
81	25.32	30.14	82	25.32	30.82	83	25.32	31.49	84	25.32	32.17	85	25.32	32.84
86	25.32	33.51	87	25.32	34.19	88	25.32	34.86	89	25.32	35.54	90	25.32	36.21
91	25.32	36.89	92	25.32	37.56	93	25.32	38.23	94	25.32	38.91	95	25.32	39.58
96	25.32	40.26	97	25.32	40.93	98	25.32	41.60	99	25.32	42.28	100	25.32	42.95

101	25.32	43.63	102	25.32	44.30	103	25.32	44.98	104	25.32	45.65	105	25.32	46.32
106	25.32	47.00	107	25.32	47.67	108	25.32	48.35	109	25.32	49.02	110	25.32	49.69
111	25.32	50.37	112	25.32	51.04	113	25.32	51.72	114	25.32	52.39	115	25.32	53.07
116	25.32	53.74	117	25.32	54.41	118	25.32	55.09	119	25.32	55.76	120	25.32	56.44
121	25.32	57.11	122	25.32	57.78	123	25.32	58.46	124	25.32	59.13	125	25.32	59.81
126	25.32	60.48	127	25.32	61.16	128	25.32	61.83	129	25.32	62.50	130	25.32	63.18
131	25.32	63.85	132	25.32	64.53	133	25.32	65.20	134	25.32	65.87	135	25.32	66.55
136	25.32	67.22	137	25.32	67.90	138	25.32	68.57	139	25.32	69.25	140	25.32	69.92
141	25.32	70.59	142	25.32	71.27	143	25.32	71.94	144	25.32	72.62	145	25.32	73.29
146	25.32	73.29	147	25.14	72.77	148	24.95	72.24	149	24.75	71.72	150	24.55	71.19
151	24.35	70.67	152	24.15	70.14	153	23.95	69.62	154	23.74	69.09	155	23.54	68.57
156	23.34	68.04	157	23.14	67.52	158	22.94	66.99	159	22.74	66.47	160	22.54	65.95
161	22.33	65.42	162	22.13	64.90	163	21.93	64.37	164	21.73	63.85	165	21.53	63.32
166	21.33	62.80	167	21.13	62.27	168	20.92	61.75	169	20.72	61.22	170	20.52	60.70
171	20.32	60.17	172	20.12	59.65	173	19.92	59.12	174	19.72	58.60	175	19.51	58.08
176	19.31	57.55	177	19.11	57.03	178	18.91	56.50	179	18.71	55.98	180	18.51	55.45
181	18.31	54.93	182	18.11	54.40	183	17.90	53.88	184	17.70	53.35	185	17.50	52.83
186	17.30	52.30	187	17.10	51.78	188	16.90	51.26	189	16.70	50.73	190	16.49	50.21
191	16.29	49.68	192	16.09	49.16	193	15.89	48.63	194	15.69	48.11	195	15.49	47.58
196	15.29	47.06	197	15.08	46.53	198	14.88	46.01	199	14.68	45.48	200	14.48	44.96
201	14.28	44.43	202	14.08	43.91	203	13.88	43.39	204	13.67	42.86	205	13.47	42.34
206	13.27	41.81	207	13.07	41.29	208	12.87	40.76	209	12.67	40.24	210	12.47	39.71
211	12.26	39.19	212	12.06	38.66	213	11.86	38.14	214	11.66	37.61	215	11.46	37.09
216	11.26	36.57	217	11.06	36.04	218	10.85	35.52	219	10.65	34.99	220	10.45	34.47
221	10.25	33.94	222	10.05	33.42	223	9.85	32.89	224	7.65	32.37	225	9.44	31.84
226	9.24	31.32	227	9.04	30.79	228	8.84	30.27	229	8.64	29.74	230	8.44	29.22
231	8.24	28.70	232	8.03	28.17	233	7.83	27.65	234	7.63	27.12	235	7.43	26.60
236	7.43	26.60	237	7.02	26.16	238	6.58	25.76	239	6.12	25.38	240	5.63	25.03
241	5.13	24.70	242	4.61	24.41	243	4.07	24.15	244	3.51	23.93	245	2.95	23.73
246	2.37	23.57	247	1.79	23.45	248	1.19	23.36	249	.60	23.31	250	.00	23.29
251-1000	.00	.00												

PACKAGE 3

N	X	Y	N	X	Y	N	X	Y	N	X	Y	N	X	Y
1	5.00	8.29	2	5.65	8.29	3	6.30	8.29	4	6.95	8.29	5	7.60	8.29
6	8.25	8.29	7	8.90	8.29	8	9.55	8.29	9	10.20	8.29	10	10.85	8.29
11	11.50	8.29	12	12.15	8.29	13	12.80	8.29	14	13.45	8.29	15	14.10	8.29
16	14.75	8.29	17	15.40	8.29	18	16.05	8.29	19	16.70	8.29	20	17.35	8.29
21	18.00	8.29	22	18.65	8.29	23	19.30	8.29	24	19.95	8.29	25	20.60	8.29
26	21.25	8.29	27	21.90	8.29	28	22.55	8.29	29	23.20	8.29	30	23.85	8.29
31	24.50	8.29	32	25.14	8.29	33	25.73	8.29	34	26.29	8.29	35	26.83	8.29
36	27.33	8.29	37	27.82	8.29	38	28.28	8.29	39	28.73	8.29	40	29.16	8.29
41	29.16	8.29	42	29.16	8.95	43	29.16	9.60	44	29.16	10.26	45	29.16	10.92
46	29.16	11.57	47	29.16	12.23	48	29.16	12.89	49	29.16	13.54	50	29.16	14.20
51	29.16	14.86	52	29.16	15.51	53	29.16	16.17	54	29.16	16.83	55	29.16	17.48
56	29.16	18.14	57	29.16	18.80	58	29.16	19.45	59	29.16	20.11	60	29.16	20.76
61	29.16	21.42	62	29.16	22.08	63	29.16	22.73	64	29.16	23.39	65	29.16	24.05
66	29.16	24.70	67	29.16	25.36	68	29.16	26.02	69	29.16	26.67	70	29.16	27.33
71	29.16	27.99	72	29.16	28.64	73	29.16	29.30	74	29.16	29.96	75	29.16	30.61
76	29.16	31.27	77	29.16	31.93	78	29.16	32.58	79	29.16	33.24	80	29.16	33.90
81	29.16	34.55	82	29.16	35.21	83	29.16	35.87	84	29.16	36.52	85	29.16	37.18
86	29.16	37.84	87	29.16	38.49	88	29.16	39.15	89	29.16	39.81	90	29.16	40.46
91	29.16	41.12	92	29.16	41.77	93	29.16	42.43	94	29.16	43.09	95	29.16	43.74

96	29.16	44.40	97	29.16	45.06	98	29.16	45.71	99	29.16	46.37	100	29.16	47.03
101	29.16	47.68	102	29.16	48.34	103	29.16	49.00	104	29.16	49.65	105	29.16	50.31
106	29.16	50.97	107	29.16	51.62	108	29.16	52.28	109	29.16	52.94	110	29.16	53.59
111	29.16	54.25	112	29.16	54.91	113	29.16	55.56	114	29.16	56.22	115	29.16	56.88
116	29.16	57.53	117	29.16	58.19	118	29.16	58.85	119	29.16	59.50	120	29.16	60.16
121	29.16	60.82	122	29.16	61.47	123	29.16	62.13	124	29.16	62.78	125	29.16	63.44
126	29.16	64.10	127	29.16	64.75	128	29.16	65.41	129	29.16	66.07	130	29.16	66.72
131	29.16	67.38	132	29.16	68.04	133	29.16	68.69	134	29.16	69.35	135	29.16	70.01
136	29.16	70.66	137	29.16	71.32	138	29.16	71.98	139	29.16	72.63	140	29.16	73.29
141	29.16	73.29	142	28.32	73.29	143	27.41	73.29	144	26.42	73.29	145	25.32	73.29
146	25.32	73.29	147	25.32	72.62	148	25.32	71.94	149	25.32	71.27	150	25.32	70.59
151	25.32	69.92	152	25.32	69.25	153	25.32	68.57	154	25.32	67.90	155	25.32	67.22
156	25.32	66.55	157	25.32	65.87	158	25.32	65.20	159	25.32	64.53	160	25.32	63.85
161	25.32	63.18	162	25.32	62.50	163	25.32	61.83	164	25.32	61.16	165	25.32	60.48
166	25.32	59.81	167	25.32	59.13	168	25.32	58.46	169	25.32	57.78	170	25.32	57.11
171	25.32	56.44	172	25.32	55.76	173	25.32	55.09	174	25.32	54.41	175	25.32	53.74
176	25.32	53.07	177	25.32	52.39	178	25.32	51.72	179	25.32	51.04	180	25.32	50.37
181	25.32	49.69	182	25.32	49.02	183	25.32	48.35	184	25.32	47.67	185	25.32	47.00
186	25.32	46.32	187	25.32	45.65	188	25.32	44.98	189	25.32	44.30	190	25.32	43.63
191	25.32	42.95	192	25.32	42.28	193	25.32	41.60	194	25.32	40.93	195	25.32	40.26
196	25.32	39.58	197	25.32	38.91	198	25.32	38.23	199	25.32	37.56	200	25.32	36.89
201	25.32	36.21	202	25.32	35.54	203	25.32	34.86	204	25.32	34.19	205	25.32	33.51
206	25.32	32.84	207	25.32	32.17	208	25.32	31.49	209	25.32	30.82	210	25.32	30.14
211	25.32	29.47	212	25.32	28.80	213	25.32	28.12	214	25.32	27.45	215	25.32	26.77
216	25.32	26.10	217	25.32	25.42	218	25.32	24.75	219	25.32	24.08	220	25.32	23.40
221	25.32	22.73	222	25.32	22.05	223	25.32	21.38	224	25.32	20.71	225	25.32	20.03
226	25.32	19.36	227	25.32	18.68	228	25.32	18.01	229	25.32	17.33	230	25.32	16.66
231	25.32	15.99	232	25.32	15.31	233	25.32	14.64	234	25.32	13.96	235	25.32	13.29
236	25.32	13.29	237	24.65	13.29	238	23.95	13.29	239	23.25	13.29	240	22.55	13.29
241	21.85	13.29	242	21.14	13.29	243	20.44	13.29	244	19.74	13.29	245	19.04	13.29
246	18.34	13.29	247	17.63	13.29	248	16.93	13.29	249	16.23	13.29	250	15.53	13.29
251	14.63	13.29	252	14.13	13.29	253	13.42	13.29	254	12.72	13.29	255	12.02	13.29
256	11.32	13.29	257	10.62	13.29	258	9.91	13.29	259	9.21	13.29	260	8.51	13.29
261	7.81	13.29	262	7.11	13.29	263	6.40	13.29	264	5.70	13.29	265	5.00	13.29
266	5.00	13.29	267	5.00	12.73	268	5.00	12.18	269	5.00	11.62	270	5.00	11.07
271	5.00	10.51	272	5.00	9.96	273	5.00	9.40	274	5.00	8.85	275	5.00	8.29
276	-1000.00	.00												

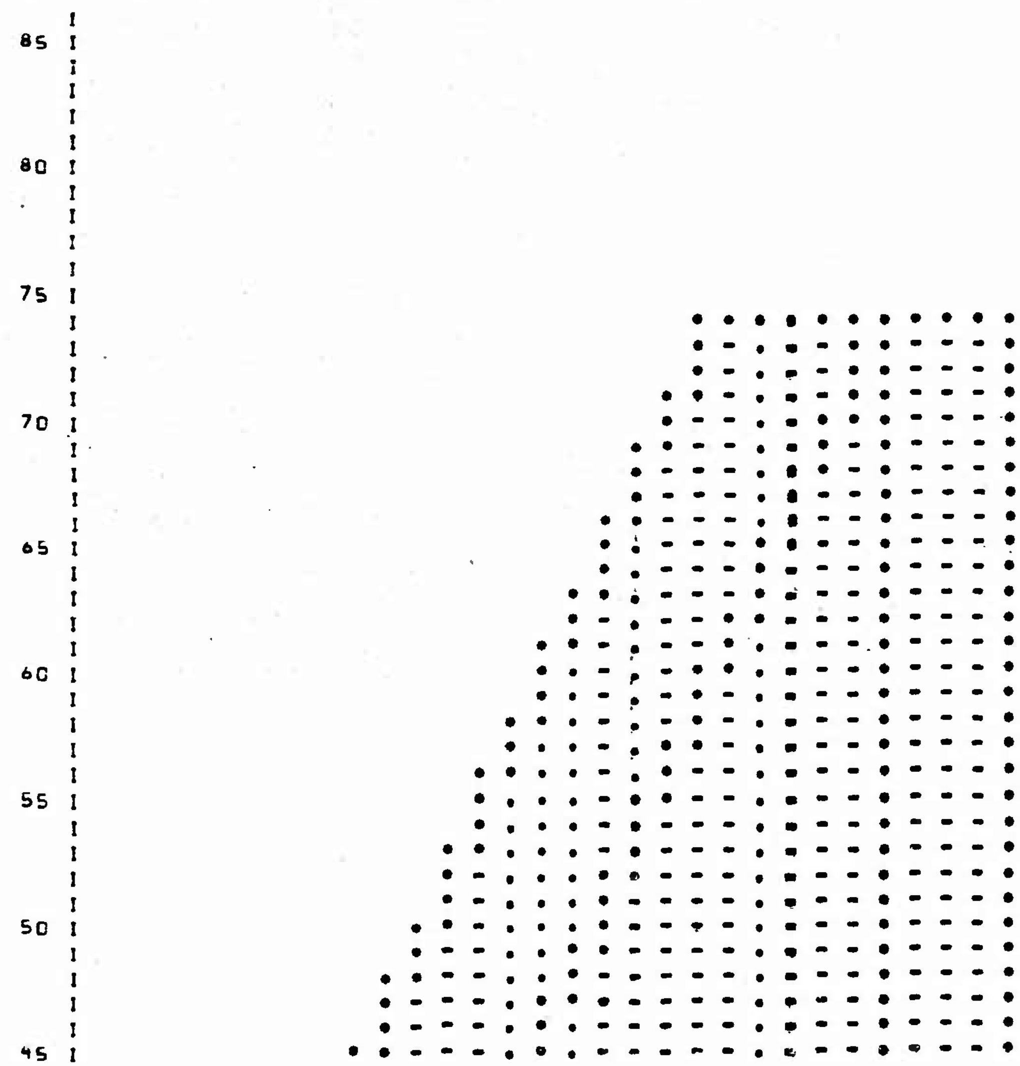
FREE SURFACE TRACERS NVRTEX= 0

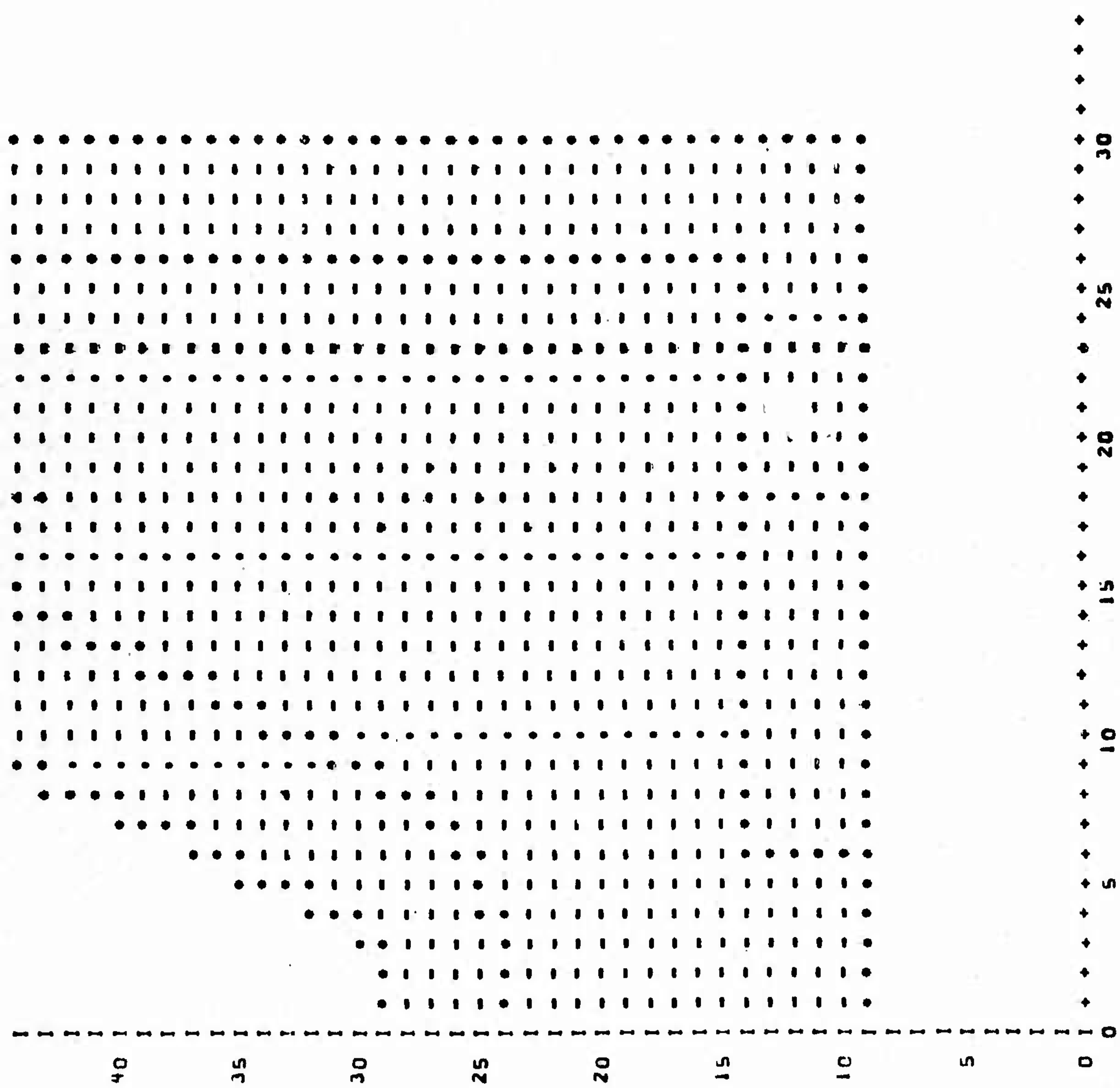
N	X	Y	N	X	Y	N	X	Y	N	X	Y	N	X	Y
1	.00	28.29	2	.49	28.31	3	.97	28.39	4	1.44	28.50	5	1.90	28.67
6	2.34	28.87	7	2.76	29.12	8	3.16	29.41	9	3.16	29.41	10	3.35	29.91
11	3.54	30.40	12	3.72	30.89	13	3.91	31.39	14	4.10	31.88	15	4.29	32.37
16	4.48	32.86	17	4.67	33.36	18	4.86	33.85	19	5.05	34.34	20	5.24	34.84
21	5.43	35.33	22	5.62	35.82	23	5.81	36.32	24	6.00	36.81	25	6.18	37.30
26	6.37	37.79	27	6.56	38.29	28	6.75	38.78	29	6.94	39.27	30	7.13	39.77
31	7.32	40.26	32	7.51	40.75	33	7.70	41.25	34	7.89	41.74	35	8.08	42.23
36	8.27	42.72	37	8.46	43.22	38	8.65	43.71	39	8.83	44.20	40	9.02	44.70
41	9.21	45.19	42	9.40	45.68	43	9.59	46.18	44	9.78	46.67	45	9.97	47.16
46	10.16	47.65	47	10.35	48.15	48	10.54	48.64	49	10.73	49.13	50	10.92	49.63
51	11.11	50.12	52	11.29	50.61	53	11.48	51.11	54	11.67	51.60	55	11.86	52.09
56	12.05	52.58	57	12.24	53.08	58	12.43	53.57	59	12.62	54.06	60	12.81	54.56
61	13.00	55.05	62	13.19	55.54	63	13.38	56.04	64	13.57	56.53	65	13.75	57.02

66	13.94	57.51	67	14.13	58.01	68	14.32	58.50	69	14.51	58.99	70	14.70	59.49
71	14.89	59.98	72	15.08	60.47	73	15.27	60.97	74	15.46	61.46	75	15.65	61.95
76	15.84	62.44	77	16.03	62.94	78	16.22	63.43	79	16.40	63.92	80	16.59	64.42
81	16.78	64.91	82	16.97	65.40	83	17.16	65.90	84	17.35	66.39	85	17.54	66.88
86	17.73	67.37	87	17.92	67.87	88	18.11	68.36	89	18.30	68.85	90	18.49	69.35
91	18.68	69.84	92	18.86	70.33	93	19.05	70.83	94	19.24	71.32	95	19.43	71.81
96	19.62	72.30	97	19.81	72.80	98	20.00	73.29	99	20.00	73.29	100	21.07	73.29
101	22.14	73.29	102	23.21	73.29	103	24.28	73.29	104	25.32	73.29	105	25.32	73.29
106	26.42	73.29	107	27.41	73.29	108	28.32	73.29	109	29.16	73.29	110	29.16	73.29
111	29.16	72.63	112	29.16	71.98	113	29.16	71.32	114	29.16	70.66	115	29.16	70.01
116	29.16	69.35	117	29.16	68.69	118	29.16	68.04	119	29.16	67.38	120	29.16	66.72
121	29.16	66.07	122	29.16	65.41	123	29.16	64.75	124	29.16	64.10	125	29.16	63.44
126	29.16	62.78	127	29.16	62.13	128	29.16	61.47	129	29.16	60.82	130	29.16	60.16
131	29.16	59.50	132	29.16	58.85	133	29.16	58.19	134	29.16	57.53	135	29.16	56.88
136	29.16	56.22	137	29.16	55.56	138	29.16	54.91	139	29.16	54.25	140	29.16	53.59
141	29.16	52.94	142	29.16	52.28	143	29.16	51.62	144	29.16	50.97	145	29.16	50.31
146	29.16	49.65	147	29.16	49.00	148	29.16	48.34	149	29.16	47.68	150	29.16	47.03
151	29.16	46.37	152	29.16	45.71	153	29.16	45.06	154	29.16	44.40	155	29.16	43.74
156	29.16	43.09	157	29.16	42.43	158	29.16	41.77	159	29.16	41.12	160	29.16	40.46
161	29.16	39.81	162	29.16	39.15	163	29.16	38.49	164	29.16	37.84	165	29.16	37.18
166	29.16	36.52	167	29.16	35.87	168	29.16	35.21	169	29.16	34.55	170	29.16	33.90
171	29.16	33.24	172	29.16	32.58	173	29.16	31.93	174	29.16	31.27	175	29.16	30.61
176	29.16	29.96	177	29.16	29.30	178	29.16	28.64	179	29.16	27.99	180	29.16	27.33
181	29.16	26.67	182	29.16	26.02	183	29.16	25.36	184	29.16	24.70	185	29.16	24.05
186	29.16	23.39	187	29.16	22.73	188	29.16	22.08	189	29.16	21.42	190	29.16	20.76
191	29.16	20.11	192	29.16	19.45	193	29.16	18.80	194	29.16	18.14	195	29.16	17.48
196	29.16	16.83	197	29.16	16.17	198	29.16	15.51	199	29.16	14.86	200	29.16	14.20
201	29.16	13.54	202	29.16	12.89	203	29.16	12.23	204	29.16	11.57	205	29.16	10.92
206	29.16	10.26	207	29.16	9.60	208	29.16	8.95	209	29.16	8.29	210	29.16	8.29
211	28.73	8.29	212	28.28	8.29	213	27.82	8.29	214	27.33	8.29	215	26.83	8.29
216	26.29	8.29	217	25.73	8.29	218	25.14	8.29	219	24.50	8.29	220	23.85	8.29
221	23.20	8.29	222	22.55	8.29	223	21.90	8.29	224	21.25	8.29	225	20.60	8.29
226	19.95	8.29	227	19.30	8.29	228	18.65	8.29	229	18.00	8.29	230	17.35	8.29
231	16.70	8.29	232	16.05	8.29	233	15.40	8.29	234	14.75	8.29	235	14.10	8.29
236	13.45	8.29	237	12.80	8.29	238	12.15	8.29	239	11.50	8.29	240	10.85	8.29
241	10.20	8.29	242	9.55	8.29	243	8.90	8.29	244	8.25	8.29	245	7.60	8.29
246	6.95	8.29	247	6.30	8.29	248	5.65	8.29	249	5.00	8.29	250	5.00	8.29
251	4.64	8.29	252	4.29	8.29	253	3.93	8.29	254	3.57	8.29	255	3.21	8.29
256	2.86	8.29	257	2.50	8.29	258	2.14	8.29	259	1.79	8.29	260	1.43	8.29
261	1.07	8.29	262	.71	8.29	263	.36	8.29	264	.00	8.29	265	-1000.00	.00

COMPRESSION CYCLE= .0 TIME= 6.79586-08 SECONDS

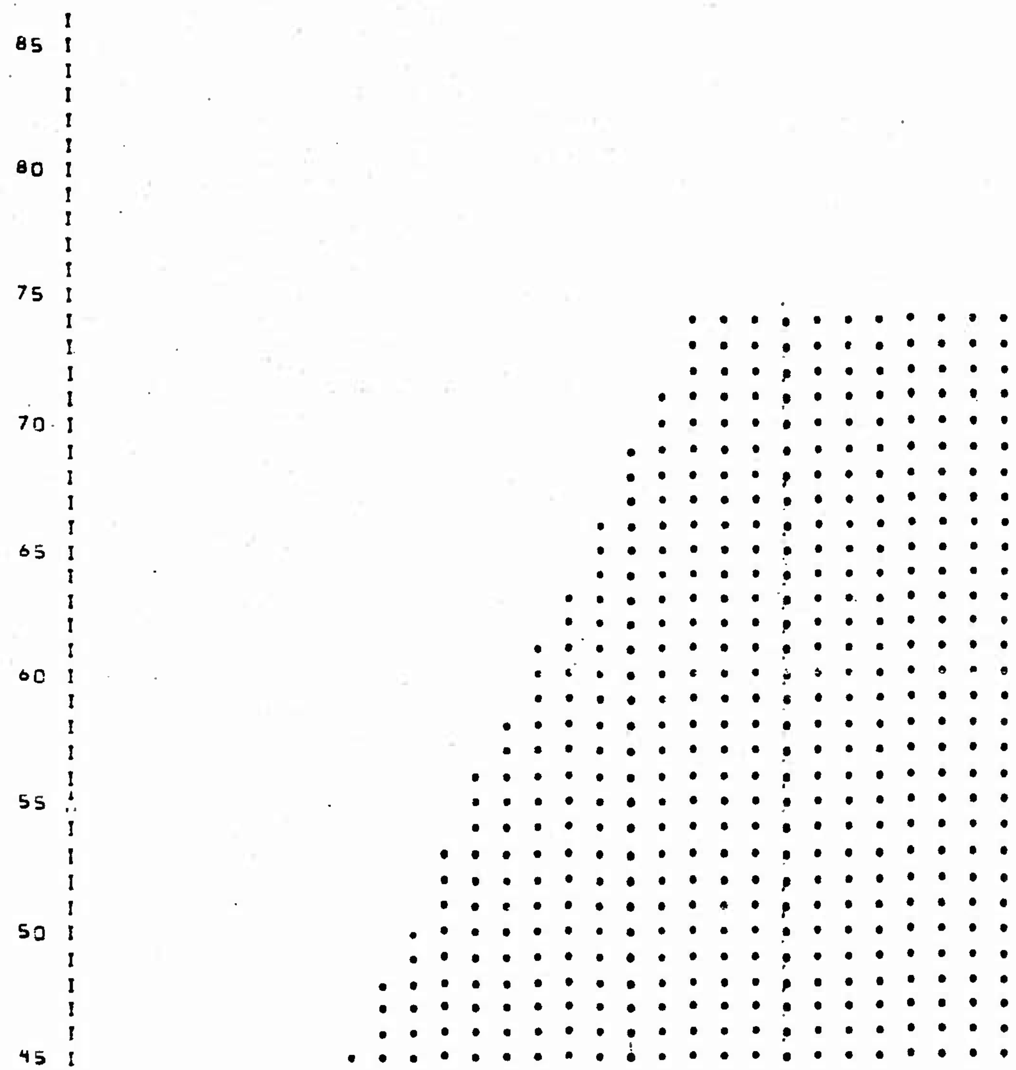
SYMBOL	.	-	A	B	C	D	E	F	G	H
MAXIMUM VALUE	1.000	1.001	1.002	1.003	1.004	1.005	1.006	1.007	1.008	1.009
SYMBOL	I	J	K	L	M	N	O	P	Q	R
MAXIMUM VALUE	1.010	1.011	1.012	1.013	1.014	1.015	1.016	1.017	1.018	1.019
SYMBOL	S	T	U	V	W	X	Y	Z		
MAXIMUM VALUE	1.020	1.021	1.022	1.023	1.024	1.025	1.026	1.027		

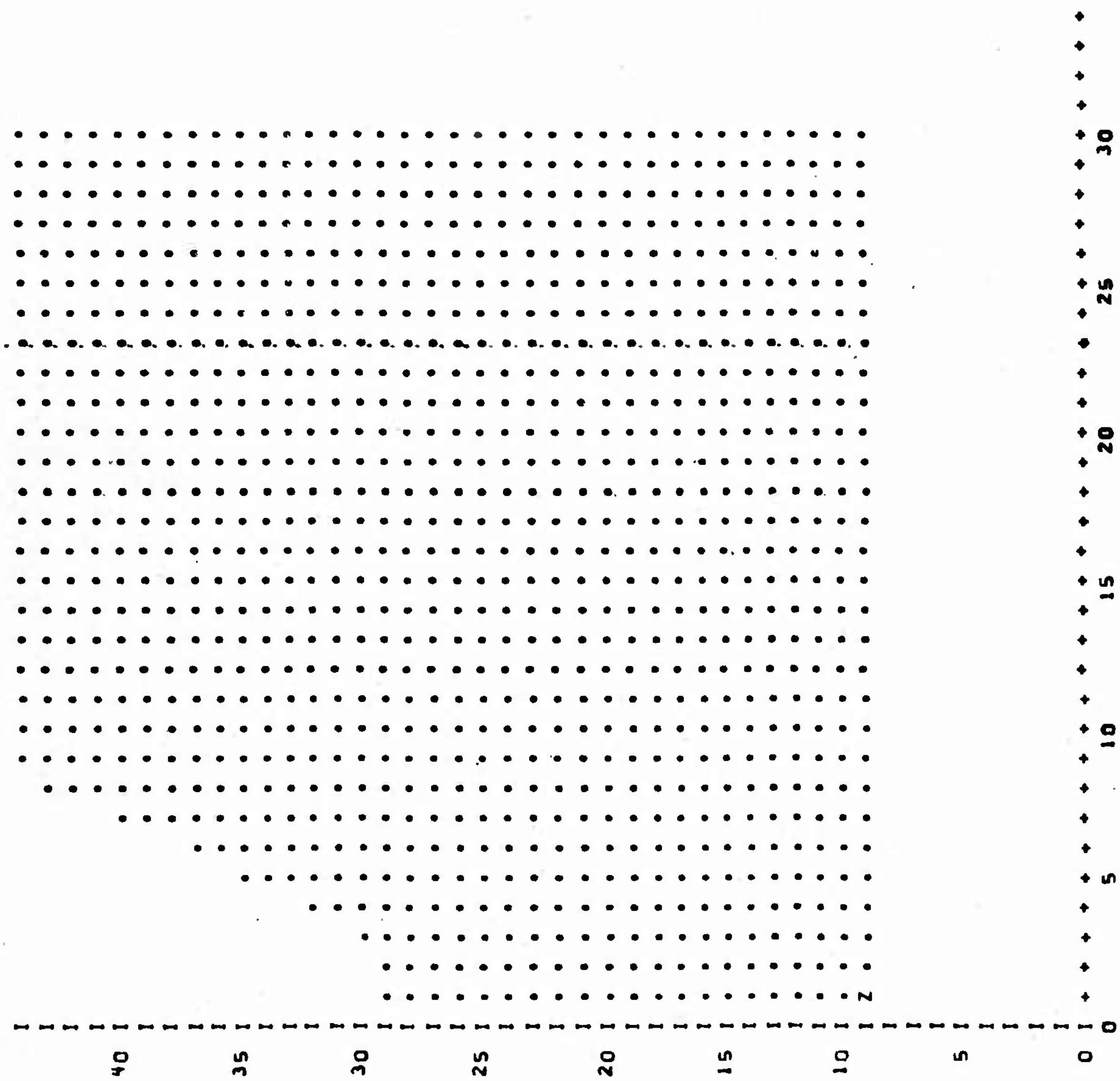



0
5
10
15
20
25
30
35
40
0
5
10
15
20
25
30

PRESSURE CYCLE= .0 TIME= 6.79586-08 SECONDS

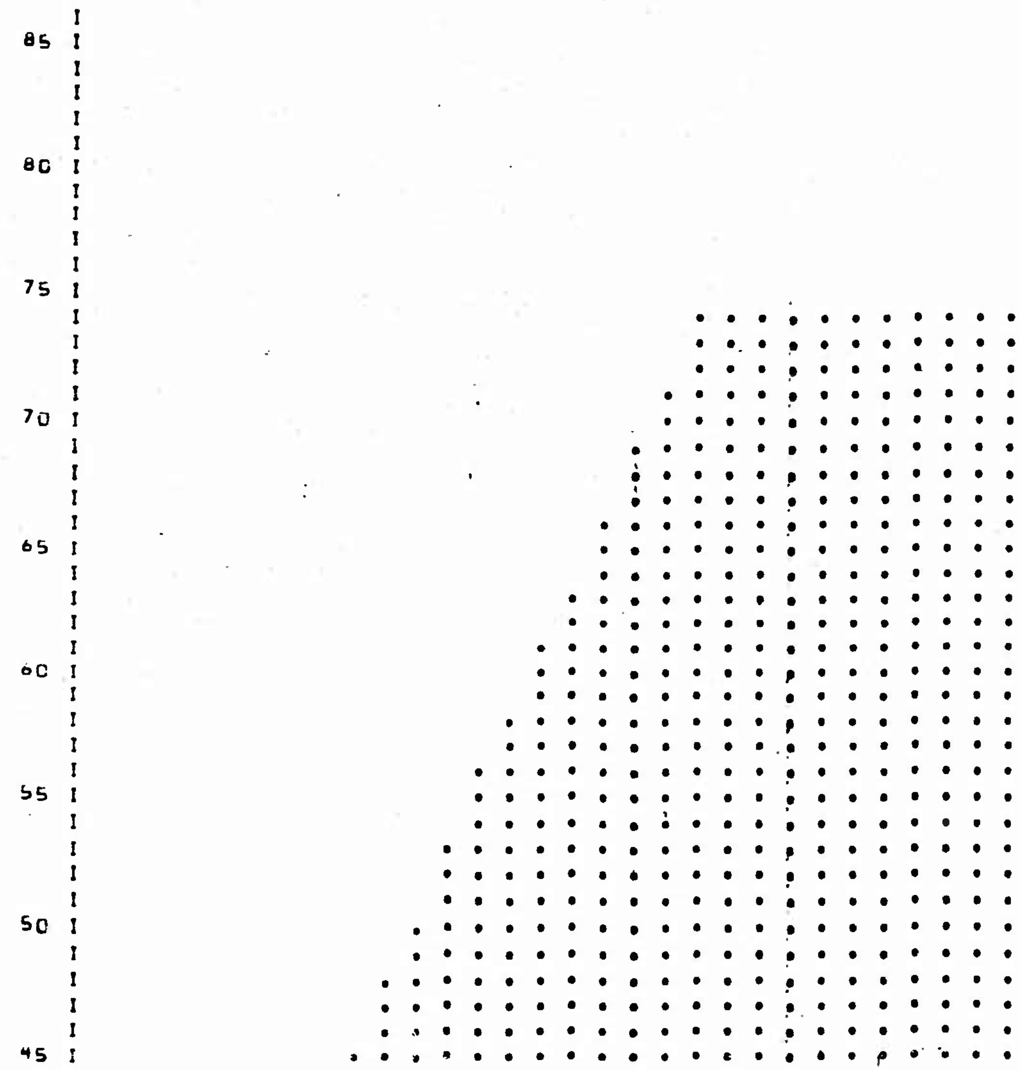
SYMBOL	•	-	A	B	C	D	E	F	G	H
MAXIMUM VALUE	0.00	1.79+08	1.79+09	3.58+09	5.37+09	7.17+09	8.96+09	1.07+10	1.25+10	1.43+10
SYMBOL	I	J	K	L	M	N	O	P	Q	R
MAXIMUM VALUE	1.61+10	1.79+10	1.97+10	2.15+10	2.33+10	2.51+10	2.69+10	2.87+10	3.05+10	3.22+10
SYMBOL	S	T	U	V	W	X	Y	Z		
MAXIMUM VALUE	3.40+10	3.58+10	3.76+10	3.94+10	4.12+10	4.30+10	4.48+10	4.66+10		

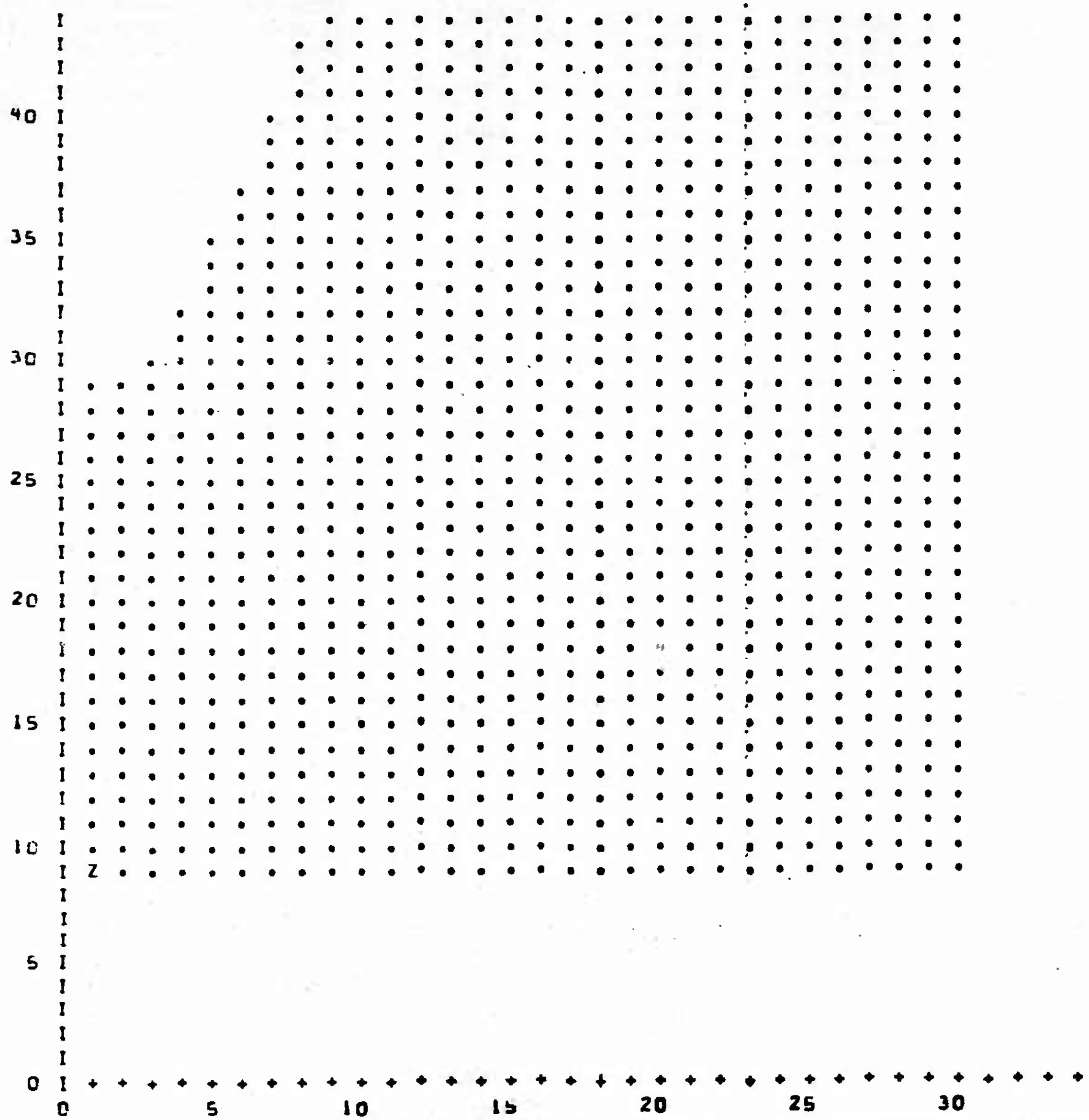



0 5 10 15 20 25 30 35 40
0 5 10 15 20 25 30
Z

SPECIFIC INTERNAL ENERGY CYCLE= .0 TIME= 6.79586-08 SECONDS

SYMBOL	.	-	A	B	C	D	E	F	G	H
MAXIMUM VALUE	0.00	1.90+08	1.90+09	3.81+09	5.71+09	7.62+09	9.52+09	1.14+10	1.33+10	1.52+10
SYMBOL	I	J	K	L	M	N	O	P	Q	R
MAXIMUM VALUE	1.71+10	1.90+10	2.09+10	2.28+10	2.47+10	2.67+10	2.86+10	3.05+10	3.24+10	3.43+10
SYMBOL	S	T	U	V	W	X	Y	Z		
MAXIMUM VALUE	3.62+10	3.81+10	4.00+10	4.19+10	4.38+10	4.57+10	4.76+10	4.95+10		





I = 1 R(I) = 1.0000-01 DR(I) = 1.0000000-01 TAU(I) = 3.1415927-02 T = 6.7958614-08 CYCLE = 0

J	MFLAG	U	V	P	SIE	COMP	TMASS	SZZ	SRR	SRZ	Z
11	2	0.0000	0.0000	0.0000	0.0000	1.00000+00	5.3941-03	0.0000	0.0000	0.0000	1.271+0
10	2	0 0000	0 0000	0 0000	0 0000	1 00000 00	[illegible] 03	0.0000	0.0000	0.0000	[illegible]

9	247	0.0000	0.0000	4.6573+10	4.9500+10	0.00000	3.8298-03	0.0000	0.0000	0.0000	1.071+00
	NMAT	US	VS	RHO	SIE	COMP	MASS	FRAC. VOL.	RHO(NVOID)=1.0		THETA= -1.00
	2	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.00000			
	21	0.0000	0.0000	1.7170+00	4.9500+10	1.00000+00	3.8298-03	7.10000-01			
	4	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.00000			

J	MFLAG	U	V	P	SIE	COMP	TMASS	SZZ	SRR	SRZ	Z
8	0	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.0000	0.0000	0.0000	9.710-01
7	0	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.0000	0.0000	0.0000	8.710-01
6	0	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.0000	0.0000	0.0000	7.710-01
5	0	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.0000	0.0000	0.0000	6.710-01
4	0	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.0000	0.0000	0.0000	5.610-01
3	0	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.0000	0.0000	0.0000	4.400-01
2	0	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.0000	0.0000	0.0000	3.070-01
1	0	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.0000	0.0000	0.0000	1.610-01

I = 2 R(I) = 2.0000-01 DR(I) = 1.0000000-01 TAU(I) = 9.4247780-02 T = 6.7958614-08 CYCLE = 0

J	MFLAG	U	V	P	SIE	COMP	TMASS	SZZ	SRR	SRZ	Z
11	2	0.0000	0.0000	0.0000	0.0000	1.00000+00	1.6182-02	0.0000	0.0000	0.0000	1.271+00
10	2	0.0000	0.0000	0.0000	0.0000	1.00000+00	1.6182-02	0.0000	0.0000	0.0000	1.171+00
9	248	0.0000	0.0000	0.0000	0.0000	0.00000	1.1489-02	0.0000	0.0000	0.0000	1.071+00
	NMAT	US	VS	RHO	SIE	COMP	MASS	FRAC. VOL.	RHO(NVOID)=1.0		THETA= -1.00
	2	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.00000			
	21	0.0000	0.0000	1.7170+00	0.0000	1.00000+00	1.1489-02	7.10000-01			
	4	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.00000			

J	MFLAG	U	V	P	SIE	COMP	TMASS	SZZ	SRR	SRZ	Z
8	0	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.0000	0.0000	0.0000	9.710-01
7	0	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.0000	0.0000	0.0000	8.710-01
6	0	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.0000	0.0000	0.0000	7.710-01
5	0	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.0000	0.0000	0.0000	6.710-01
4	0	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.0000	0.0000	0.0000	5.610-01
3	0	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.0000	0.0000	0.0000	4.400-01
2	0	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.0000	0.0000	0.0000	3.070-01
1	0	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.0000	0.0000	0.0000	1.610-01

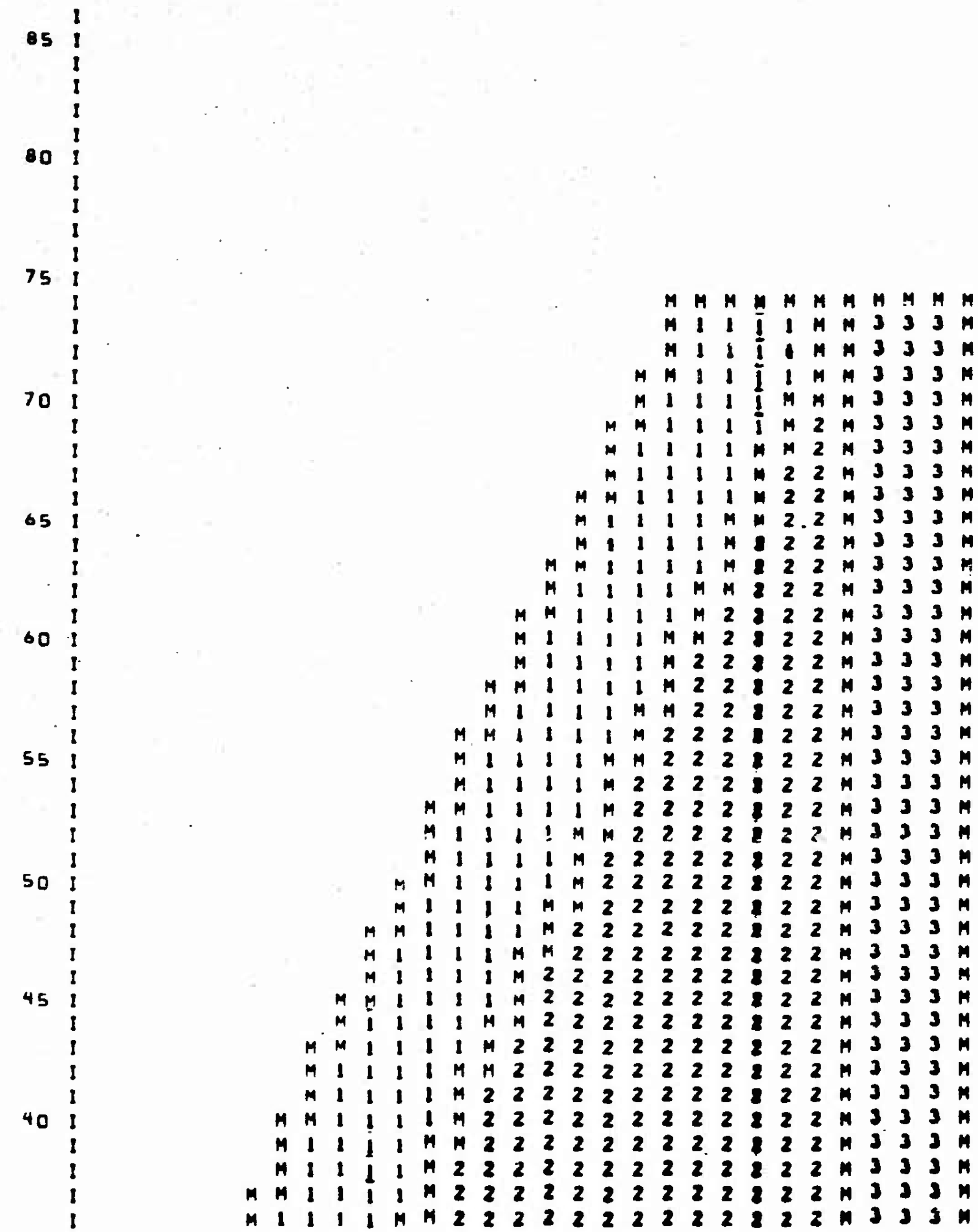
I = 3 R(I) = 3.0000-01 DR(I) = 1.0000000-01 TAU(I) = 1.5707963-01 T = 6.7958614-08 CYCLE = 0

J	MFLAG	U	V	P	SIE	COMP	TMASS	SZZ	SRR	SRZ	Z
11	2	0.0000	0.0000	0.0000	0.0000	1.00000+00	2.6971-02	0.0000	0.0000	0.0000	1.271+00
10	2	0.0000	0.0000	0.0000	0.0000	1.00000+00	2.6971-02	0.0000	0.0000	0.0000	1.171+00
9	249	0.0000	0.0000	0.0000	0.0000	0.00000	1.9149-02	0.0000	0.0000	0.0000	1.071+00
	NMAT	US	VS	RHO	SIE	COMP	MASS	FRAC. VOL.	RHO(NVOID)=1.0		THETA= -1.00
	2	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.00000			
	21	0.0000	0.0000	1.7170+00	0.0000	1.00000+00	1.9149-02	7.10000-01			
	4	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.00000			

J	HFLAG	U	V	P	SIE	COMP	TMASS	SZZ	SRR	SRZ	Z
8	0	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.0000	0.0000	0.0000	9.710-0
7	0	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.0000	0.0000	0.0000	8.710-0
6	0	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.0000	0.0000	0.0000	7.710-0
5	0	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.0000	0.0000	0.0000	6.710-0
4	0	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.0000	0.0000	0.0000	5.610-0
3	0	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.0000	0.0000	0.0000	4.400-0
2	0	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.0000	0.0000	0.0000	3.070-0
1	0	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.0000	0.0000	0.0000	1.610-0

SPHASE ETH= 1.89576102+08 ESUM= 1.89576100+08 EMIX= 1.89576102+08 RELERR= 0.00000000
HPHASE ETH= 1.89576102+08 ESUM= 1.89576100+08 EMIX= 1.89576102+08 RELERR= 0.00000000

DISPLAY OF MIXED AND PURE CELLS   M = MIXED CELL   NUMERAL N = PURE CELL OF PACKAGE N MATERIAL



```
35 I         M M 1 1 1 1 M 2 2 2 2 2 2 2 2 2 2 2 2 2 2 M 3 3 3 M
   I         M 1 1 1 1 M M 2 2 2 2 2 2 2 2 2 2 2 2 2 2 M 3 3 3 M
   I         M 1 1 1 1 M 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 M 3 3 3 M
   I       M M 1 1 1 1 M 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 M 3 3 3 M
   I       M 1 1 1 1 M M 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 M 3 3 3 M
30 I     M M 1 1 1 1 M 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 M 3 3 3 M
   I M M M 1 1 1 1 M M 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 M 3 3 3 M
   I 1 1 1 1 1 1 1 M 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 M 3 3 3 M
   I 1 1 1 1 1 1 M M 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 M 3 3 3 M
   I 1 1 1 1 1 M M 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 M 3 3 3 M
25 I 1 1 1 M M M 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 M 3 3 3 M
   I M M M M 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 M 3 3 3 M
   I 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 M 3 3 3 M
   I 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 M 3 3 3 M
   I 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 M 3 3 3 M
20 I 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 M 3 3 3 M
   I 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 M 3 3 3 M
   I 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 M 3 3 3 M
   I 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 M 3 3 3 M
   I 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 M 3 3 3 M
15 I 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 M 3 3 3 M
   I 2 2 2 2 2 M M M M M M M M M M M M M M M M M M M M M 3 3 3 M
   I 2 2 2 2 2 M 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 M
   I 2 2 2 2 2 M 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 M
   I 2 2 2 2 2 M 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 M
10 I 2 2 2 2 2 M 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 M
   I M M M M M M M M M M M M M M M M M M M M M M M M M M M M M M
   I
   I
   I
 5 I
   I
   I
   I
   I
 0 I + + + + + + + + + + + + + + + + + + + + + + + + + + + + + + + + + + +
     0         5         10        15        20        25        30

TPHASE  ETH=    1.89576102+08   ESUM=   1.89576100+08   EMIX=   1.89576102+08   RELERR=   0.00000000
CYCLE   1

CDT  1   9  T= 6.8696827-08  DT= 1.4748922-09  MAXCUV= 2.7120626+05  MAXUV= 2.8202778+02  UMIN= 2.7120626+00  PMIN= 5.0000000+
SPHASE  ETH=    1.89576102+08   ESUM=   1.89576100+08   EMIX=   1.89576102+08   RELERR=   0.00000000
HPHASE  ETH=    1.89576102+08   ESUM=   1.89576102+08   EMIX=   1.89576104+08   RELERR=   1.05498529-08
TPHASE  ETH=    1.89576102+08   ESUM=   1.89576102+08   EMIX=   1.89576104+08   RELERR=   1.05498529-08
CYCLE   2

CDT  1   9  T= 7.0171719-08  DT= 2.9436727-09  MAXCUV= 2.7176934+05  MAXUV= 8.4549666+02  UMIN= 2.7176934+00  PMIN= 5.0000000+
SPHASE  ETH=    1.89576102+08   ESUM=   1.89576102+08   EMIX=   1.89576104+08   RELERR=   1.05498529+08
HPHASE  ETH=    1.89576102+08   ESUM=   1.89576102+08   EMIX=   1.89576104+08   RELERR=   1.05498529+08
TPHASE  ETH=    1.89576102+08   ESUM=   1.89576102+08   EMIX=   1.89576104+08   RELERR=   1.05498529+08
CYCLE   3

CDT  1   9  T= 7.3115391-08  DT= 5.8631246-09  MAXCUV= 2.7289203+05  MAXUV= 1.9700963+03  UMIN= 2.7289203+00  PMIN= 5.0000000+
SPHASE  ETH=    1.89576102+08   ESUM=   1.89576102+08   EMIX=   1.89576104+08   RELERR=   1.05498529+08
```

11.2 PERFORATION OF A THIN TARGET

This calculation is presented here to illustrate the use of the HELP plugging option to simulate the perforation of a thin metal plate by a blunt metal projectile. (See Chapter VI on the HELP plugging model and Section 12.2 for results of a plugging calculation.) As dictated by the plugging model, this calculation consists of three material packages and a void (NMAT = 3): package one is the steel projectile and its initial axial velocity is 3.71×10^4 cm/sec; package two is to be the plug (the plug has no volume at t = 0.); package three is the aluminum target, and package four is the void. (The void package number is always NMAT + 1.)

Figure 11.4 shows the initial configuration of the problem as well as the passive tracer particles which are automatically generated in the plugging region of the target when PLGOPT = 1. Figure 11.5 shows the initial zoning of the grid relative to the dimensions of the projectile and target. The finest zoning was chosen to be in the region of the impact and in the region where the plug is expected to form. The value of DY(1) was chosen so that the initial projectile-target interface would be coincident with a grid line, a desirable procedure but not a requirement. The coarsest zoning is at the lower portion of the projectile and at the right end of the target, where there is no need for a highly resolved solution.

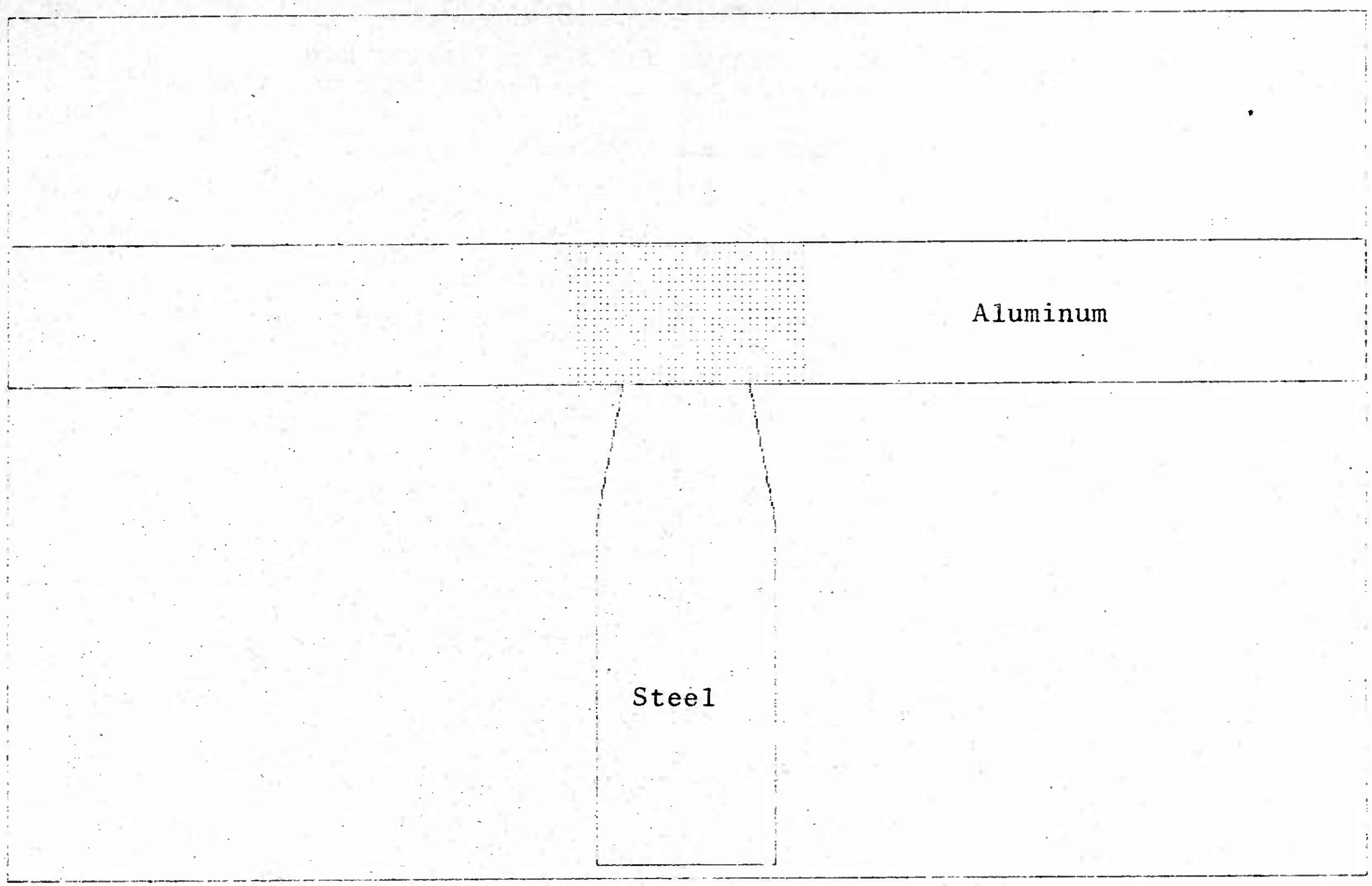


Figure 11.4--Initial configuration of the perforation of a thin target calculation. The dots represent the passive tracers which are automatically generated in the plugging region of the target.

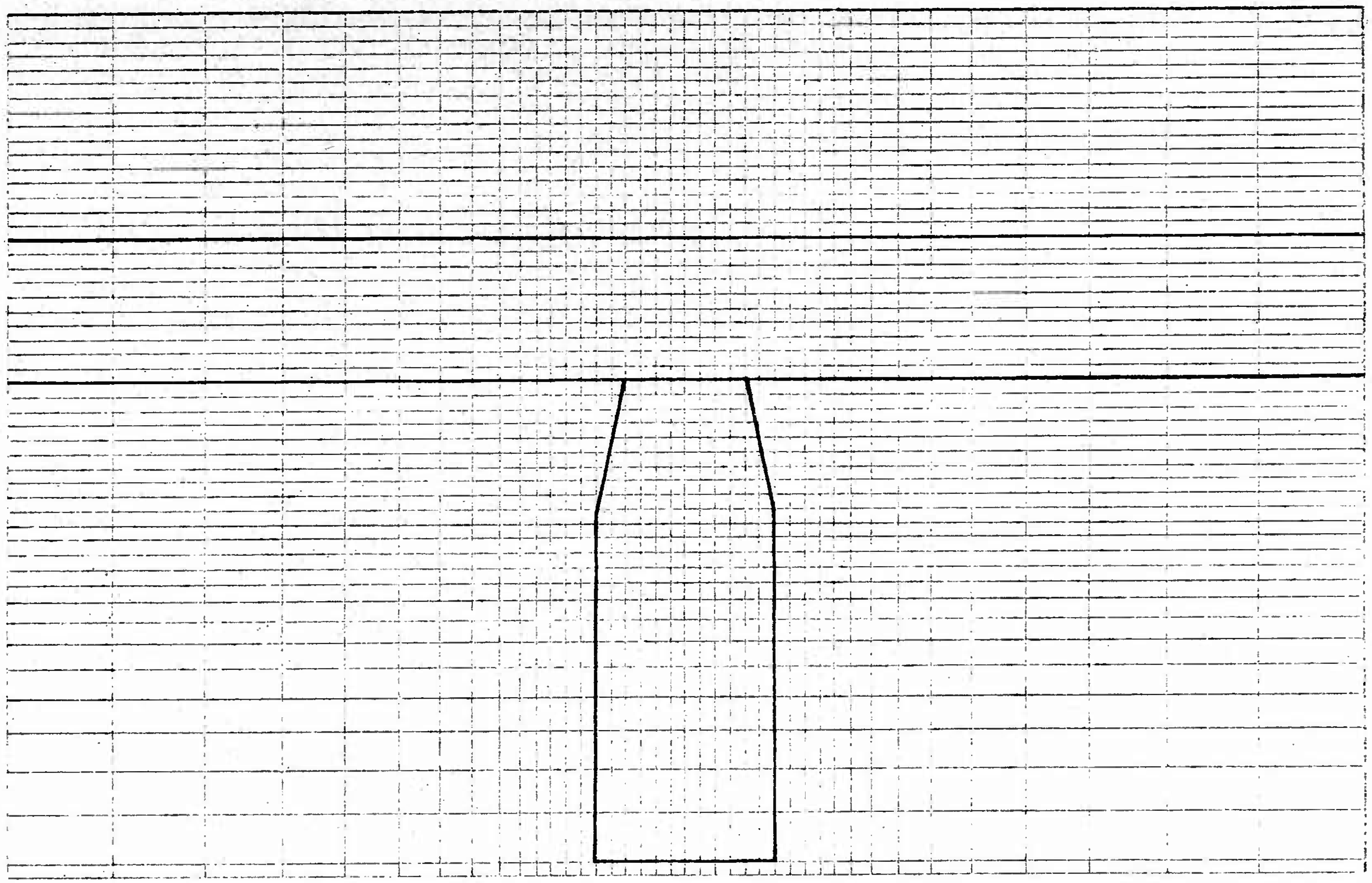


Figure 11.5--Initial zoning of the grid relative to the dimensions of the projectile and target in the perforation of a thin target calculation.

The Z-block variables which must be defined for a plugging calculation are:

Z(111)	PLGOPT	a flag which, when set to 1.0, activates the plugging mechanisms
Z(59)	PLWMIN	the specific plastic work limit for advancing the vertical edge of the plug
Z(56) Z(60) Z(61)	IPLGRT IPLGBT IPLGTP	the rightmost column, the bottom row and the top row of the region of the target where the passive tracers are generated and where the plug is expected to form
Z(109)	NVRTEX	the second index of the free surface tracer at the vertex of the void closing region (the top right corner of the projectile)
Z(112)	NSLD	the maximum number of slipline cells to be generated. The plugging option presumes the use of a slipline along the vertical edge of the plug.

The projectile and plug packages must be designated as "slaves" and the target as a "master" since the plugging routines make these assumptions. (Details on generating the tracer particles and sliplines for a plugging calculation are given in Section 6.1.) The user should read Chapter VI before attempting to apply the plugging option to an impact

situation. In its present form the plugging model has several limitations that the user should be aware of before using it.

The input cards for the plugging problem are listed on the following pages along with the cycle 0 output.

11.2.1 Input

```
 | 2-6 || 8-16 |                                                                     Column Indicator
1|23456|7|890123456|7890123456789012345678901234567890123456789012345678901234567890

                 PERFORATION OF A THIN TARGET                                        Heading Card
```

1	151134.		PK(1)
	1134.		PROB
2	512.		NFRELP
2	611.		NDUMP7
2	7120.		ICSTOP
	271-1.		CVIS
2	33120.		IMAX
2	35150.		JMAX
2	4211.		MAPS
2	4718.		I1
2	46127.		I2
2	49110.		IPCYCL
2	5615.		IPLGRT
	5912.1	+08	PLWHIN
2	60125.		IPLGBT
2	61134.		IPLGTP
2	6813.		NMAT
2	7212.		NTRACR
2	731400.		NMXCLS
2	7[illegible]1350.		NTPMX
2	811352.		NTCC
2	109110.		NVRTEX
	11111.		PLGOPT
2	112125.		NSLO
2	11611.		LVISC
2	118110.		NADD
2	11911.		MINX
2	120110.		MAXX
2	121120.		MINY
2	122145.		MAXY
1	50115.		TSTOP

Column Indicator

1-10	11-20	21-30	31-40	41-50	51-60	61-70		
1234567890	1234567890	1234567890	1234567890	1234567890	1234567890	1234567890	1234567890	
10 1	1 1	.06517	.07	.09	.12			DX
1 1	1 1	.14	.18	.23	.28			
1 1	1 999	.34	.40	.46				
1 1	1 1	.0605	.22306	.19619	.17094			DY
1 1	1 1	.14894	.12977	.11307	.09852			
1 1	11 29	.08584	.07480	.06517	.06350			
999								
0								MFLAG(2)
3	7.8	0.	0.	3.71	+04			MAT, ρ, E_I, U, V
4	2.79	0.	0.	0.				
4	2.79	0.	0.	0.				
6.0	+090.	0.	1.3	+108.0	+11.97			Y_o, Y_1, Y_2, E_m, G, AMDM
3.0	+390.	0.	7.3	+092.74	+11.985			
3.0	+390.	0.	7.3	+392.74	+11.985			

```
                                                                          Column Indicator
 1-5 |6-10 |11-15|16-20|  21-30    |  31-40    |
12345|67890|12345|67890|1234567890|1234567890|1234567890123456789012345678901234567890

    1     1    18
0.        .06       .39       .06
    2     1    60
.39       .06       .39       1.588                  Material Tracers
    3     1    24                                     for Package 1
.39       1.538     .276      2.209                    (Projectile)
   -1     1    12
.276      2.209     0.        2.209

    1     2    12                                     Material Tracers
0.        2.209     .276      2.209                   for Package 2
   -1     2    12                                        (Plug)
.276      2.209     0.        2.209

    1     3    12
0.        2.209     .276      2.209                   Material Tracers
    1     3    30                                     for Package 3
.276      2.209     1.0       2.209                     (Target)
    1     3    20
1.05      2.209     2.962     2.209
   -1     3    50
2.962     2.844     0.        2.844

    1     4    50
0.        2.844     2.962     2.844
    1     4    20                                     Material Tracers
2.962     2.209     1.05      2.209                   for Package 4
    1     4     3                                        (Void)
1.0       2.209     .276      2.209
    3     4    24
.276      2.209     .39       1.588
    2     4    60
.39       1.588     .39       .06
   -1     4    18
.39       .06       0.        .06

  100                                                 End of Material Tracer Data
```

```
                                                                                       Column Indicator >
 1-5 |6-10 |11-15|16-20|21-25|26-30|
12345|67890|12345|67890|12345|67890|12345678901234567890123456789012345678901234567890

    0    1    0  132    0  133  ]
    0    2    0   12    0   32  ]  Slipline Endpoints
    3    0   12    0   32    0  ]

0                                  Detonation Point (dummy card)

1  15010.                          End of Input
```

11.2.2 Cycle 0 Output

```
                 PERFORATION OF A THIN TARGET

   INPUT CARDS


1    156  1   3.400000+01

   INPUT CARDS


0      1  1   3.400000+01
2      5  1   2.000000+00
2      6  1   1.000000+00
2      7  1   2.000000+01
0     27  1  -1.000000+00
2     33  1   2.000000+01
2     35  1   5.000000+01
2     42  1   1.000000+00
2     47  1   8.000000+00
2     48  1   2.700000+01
2     49  1   1.000000+01
2     56  1   8.000000+00
0     59  1   2.100000+08
2     60  1   2.500000+01
2     61  1   3.400000+01
2     68  1   3.000000+00
2     72  1   2.000000+00
2     73  1   4.000000+02
2     78  1   3.500000+02
2     81  1   3.520000+02
2    109  1   1.000000+02
0    111  1   1.000000+00
2    112  1   2.500000+01
2    116  1   1.000000+00
2    118  1   1.000000+01
2    119  1   1.000000+00
2    120  1   1.000000+01
2    121  1   2.000000+01
2    122  1   4.500000+01
1     50  1   0.000000
 TYPE=    1     PACKAGE=  1      NUMBER OF POINTS=   18
 XI=    .0000000          YI=    .6000000-01   X2=   .3900000+00    Y2=   .6000000-01
 TYPE=    2     PACKAGE=  1      NUMBER OF POINTS=   60
 XI=    .3900000+00       YI=    .6000000-01   X2=   .3900000+00    Y2=   .1588000+01
 TYPE=    3     PACKAGE=  1      NUMBER OF POINTS=   24
 XI=    .3900000+00       YI=    .1588000+01   X2=   .2760000+00    Y2=   .2209000+01
```

```
TYPE=  -1     PACKAGE=  1      NUMBER OF POINTS=   12
X1=   .2760000+00      Y1=   .2209000+01      X2=   .0000000          Y2=   .2209000+01
TYPE=   1     PACKAGE=  2      NUMBER OF POINTS=   12
X1=   .0000000         Y1=   .2209000+01      X2=   .2760000+00       Y2=   .2209000+01
TYPE=  -1     PACKAGE=  2      NUMBER OF POINTS=   12
X1=   .2760000+00      Y1=   .2209000+01      X2=   .0000000          Y2=   .2209000+01
TYPE=   1     PACKAGE=  3      NUMBER OF POINTS=   12
X1=   .0000000         Y1=   .2209000+01      X2=   .2760000+00       Y2=   .2209000+01
TYPE=   1     PACKAGE=  3      NUMBER OF POINTS=   30
X1=   .2760000+00      Y1=   .2209000+01      X2=   .1000000+01       Y2=   .2209000+01
TYPE=   1     PACKAGE=  3      NUMBER OF POINTS=   20
X1=   .1050000+01      Y1=   .2209000+01      X2=   .2962000+01       Y2=   .2209000+01
TYPE=  -1     PACKAGE=  3      NUMBER OF POINTS=   50
X1=   .2962000+01      Y1=   .2844000+01      X2=   .0000000          Y2=   .2844000+01
TYPE=   1     PACKAGE=  4      NUMBER OF POINTS=   50
X1=   .0000000         Y1=   .2844000+01      X2=   .2962000+01       Y2=   .2844000+01
TYPE=   1     PACKAGE=  4      NUMBER OF POINTS=   20
X1=   .2962000+01      Y1=   .2209000+01      X2=   .1050000+01       Y2=   .2209000+01
TYPE=   1     PACKAGE=  4      NUMBER OF POINTS=   30
X1=   .1000000+01      Y1=   .2209000+01      X2=   .2760000+00       Y2=   .2209000+01
TYPE=   3     PACKAGE=  4      NUMBER OF POINTS=   24
X1=   .2760000+00      Y1=   .2209000+01      X2=   .3900000+00       Y2=   .1588000+01
TYPE=   2     PACKAGE=  4      NUMBER OF POINTS=   60
X1=   .3900000+00      Y1=   .1588000+01      X2=   .3900000+00       Y2=   .6000000-01
TYPE=  -1     PACKAGE=  4      NUMBER OF POINTS=   18
X1=   .3900000+00      Y1=   .6000000-01      X2=   .0000000          Y2=   .6000000-01
TYPE= 100     PACKAGE=  0      NUMBER OF POINTS=    0
```

DEFINITION OF SLIDE ENDPOINTS

PKG. NO.	MASTER	SLAVE	NBGM	NBGS	NENDM	NENDS
1	0	1	0	102	0	103
2	0	2	0	12	0	32
3	3	0	12	0	32	0

CELL CENTERED TRACERS

1	.25	24.25	2	.75	24.25	3	.25	24.75	4	.75	24.75	5	.25	25.25
6	.75	25.25	7	.25	25.75	8	.75	25.75	9	.25	26.25	10	.75	26.25
11	.25	26.75	12	.75	26.75	13	.25	27.25	14	.75	27.25	15	.25	27.75
16	.75	27.75	17	.25	28.25	18	.75	28.25	19	.25	28.75	20	.75	28.75
21	.25	29.25	22	.75	29.25	23	.25	29.75	24	.75	29.75	25	.25	30.25
26	.75	30.25	27	.25	30.75	28	.75	30.75	29	.25	31.25	30	.75	31.25
31	.25	31.75	32	.75	31.75	33	.25	32.25	34	.75	32.25	35	.25	32.75
36	.75	32.75	37	.25	33.25	38	.75	33.25	39	.25	33.75	40	.75	33.75
41	1.25	24.25	42	1.75	24.25	43	1.25	24.75	44	1.75	24.75	45	1.25	25.25
46	1.75	25.25	47	1.25	25.75	48	1.75	25.75	49	1.25	26.25	50	1.75	26.25
51	1.25	26.75	52	1.75	26.75	53	1.25	27.25	54	1.75	27.25	55	1.25	27.75
56	1.75	27.75	57	1.25	28.25	58	1.75	28.25	59	1.25	28.75	60	1.75	28.75
61	1.25	29.25	62	1.75	29.25	63	1.25	29.75	64	1.75	29.75	65	1.25	30.25
66	1.75	30.25	67	1.25	30.75	68	1.75	30.75	69	1.25	31.25	70	1.75	31.25
71	1.25	31.75	72	1.75	31.75	73	1.25	32.25	74	1.75	32.25	75	1.25	32.75
76	1.75	32.75	77	1.25	33.25	78	1.75	33.25	79	1.25	33.75	80	1.75	33.75
81	2.25	24.25	82	2.75	24.25	83	2.25	24.75	84	2.75	24.75	85	2.25	25.25
86	2.75	25.25	87	2.25	25.75	88	2.75	25.75	89	2.25	26.25	90	2.75	26.25
91	2.25	26.75	92	2.75	26.75	93	2.25	27.25	94	2.75	27.25	95	2.25	27.75

96	2.75	27.75	97	2.25	28.25	98	2.75	28.25	99	2.25	28.75	100	2.75	28.75
101	2.25	29.25	102	2.75	29.25	103	2.25	29.75	104	2.75	29.75	105	2.25	30.25
106	2.75	30.25	107	2.25	30.75	108	2.75	30.75	109	2.25	31.25	110	2.75	31.25
111	2.25	31.75	112	2.75	31.75	113	2.25	32.25	114	2.75	32.25	115	2.25	32.75
116	2.75	32.75	117	2.25	33.25	118	2.75	33.25	119	2.25	33.75	120	2.75	33.75
121	3.25	24.25	122	3.75	24.25	123	3.25	24.75	124	3.75	24.75	125	3.25	25.25
126	3.75	25.25	127	3.25	25.75	128	3.75	25.75	129	3.25	26.25	130	3.75	26.25
131	3.25	26.75	132	3.75	26.75	133	3.25	27.25	134	3.75	27.25	135	3.25	27.75
136	3.75	27.75	137	3.25	28.25	138	3.75	28.25	139	3.25	28.75	140	3.75	28.75
141	3.25	29.25	142	3.75	29.25	143	3.25	29.75	144	3.75	29.75	145	3.25	30.25
146	3.75	30.25	147	3.25	30.75	148	3.75	30.75	149	3.25	31.25	150	3.75	31.25
151	3.25	31.75	152	3.75	31.75	153	3.25	32.25	154	3.75	32.25	155	3.25	32.75
156	3.75	32.75	157	3.25	33.25	158	3.75	33.25	159	3.25	33.75	160	3.75	33.75
161	4.25	24.25	162	4.75	24.25	163	4.25	24.75	164	4.75	24.75	165	4.25	25.25
166	4.75	25.25	167	4.25	25.75	168	4.75	25.75	169	4.25	26.25	170	4.75	26.25
171	4.25	26.75	172	4.75	26.75	173	4.25	27.25	174	4.75	27.25	175	4.25	27.75
176	4.75	27.75	177	4.25	28.25	178	4.75	28.25	179	4.25	28.75	180	4.75	28.75
181	4.25	29.25	182	4.75	29.25	183	4.25	29.75	184	4.75	29.75	185	4.25	30.25
186	4.75	30.25	187	4.25	30.75	188	4.75	30.75	189	4.25	31.25	190	4.75	31.25
191	4.25	31.75	192	4.75	31.75	193	4.25	32.25	194	4.75	32.25	195	4.25	32.75
196	4.75	32.75	197	4.25	33.25	198	4.75	33.25	199	4.25	33.75	200	4.75	33.75
201	5.25	24.25	202	5.75	24.25	203	5.25	24.75	204	5.75	24.75	205	5.25	25.25
206	5.75	25.25	207	5.25	25.75	208	5.75	25.75	209	5.25	26.25	210	5.75	26.25
211	5.25	26.75	212	5.75	26.75	213	5.25	27.25	214	5.75	27.25	215	5.25	27.75
216	5.75	27.75	217	5.25	28.25	218	5.75	28.25	219	5.25	28.75	220	5.75	28.75
221	5.25	29.25	222	5.75	29.25	223	5.25	29.75	224	5.75	29.75	225	5.25	30.25
226	5.75	30.25	227	5.25	30.75	228	5.75	30.75	229	5.25	31.25	230	5.75	31.25
231	5.25	31.75	232	5.75	31.75	233	5.25	32.25	234	5.75	32.25	235	5.25	32.75
236	5.75	32.75	237	5.25	33.25	238	5.75	33.25	239	5.25	33.75	240	5.75	33.75
241	6.25	24.25	242	6.75	24.25	243	6.25	24.75	244	6.75	24.75	245	6.25	25.25
246	6.75	25.25	247	6.25	25.75	248	6.75	25.75	249	6.25	26.25	250	6.75	26.25
251	6.25	26.75	252	6.75	26.75	253	6.25	27.25	254	6.75	27.25	255	6.25	27.75
256	6.75	27.75	257	6.25	28.25	258	6.75	28.25	259	6.25	28.75	260	6.75	28.75
261	6.25	29.25	262	6.75	29.25	263	6.25	29.75	264	6.75	29.75	265	6.25	30.25
266	6.75	30.25	267	6.25	30.75	268	6.75	30.75	269	6.25	31.25	270	6.75	31.25
271	6.25	31.75	272	6.75	31.75	273	6.25	32.25	274	6.75	32.25	275	6.25	32.75
276	6.75	32.75	277	6.25	33.25	278	6.75	33.25	279	6.25	33.75	280	6.75	33.75
281	7.25	24.25	282	7.75	24.25	283	7.25	24.75	284	7.75	24.75	285	7.25	25.25
286	7.75	25.25	287	7.25	25.75	288	7.75	25.75	289	7.25	26.25	290	7.75	26.25
291	7.25	26.75	292	7.75	26.75	293	7.25	27.25	294	7.75	27.25	295	7.25	27.75
296	7.75	27.75	297	7.25	28.25	298	7.75	28.25	299	7.25	28.75	300	7.75	28.75
301	7.25	29.25	302	7.75	29.25	303	7.25	29.75	304	7.75	29.75	305	7.25	30.25
306	7.75	30.25	307	7.25	30.75	308	7.75	30.75	309	7.25	31.25	310	7.75	31.25
311	7.25	31.75	312	7.75	31.75	313	7.25	32.25	314	7.75	32.25	315	7.25	32.75
316	7.75	32.75	317	7.25	33.25	318	7.75	33.25	319	7.25	33.75	320	7.75	33.75

INPUT CARDS

```
1    150  1    0.000000

ICSTOP    IDLT    IDRT    IEXTX    IGM    IMAX    INTER    IPCYCL    IPLGBT    IPLGRT
```

20	0	0	0	0	20	0	10	25	8
IPLGTP	IPR	I1	I2	JDBT	JDTP	JEXTY	JMAX	KUNITR	KUNITW
34	35	8	27	0	0	0	50	7	7
LVISC	MAPS	MAXX	MAXY	MINX	MINY	NADD	NDUMP7	NFRELP	NLINER
1	1	10	45	1	20	10	1	2	0
NMAT	NMXCLS	NODUMP	NOSLIP	NSLD	NTCC	NTPMX	NTRACR	NUMSCA	NUMREZ
3	400	0	0	25	320	350	2	0	0
NVRTEX									
100									

BBAR	CRATIO	CVIS	CYCMX	CYCPH3	DMIN	DTMIN	EMIN	FINAL
5.0000-01	1.0000+04	-1.0000+00	2.0000+00	1.0000+00	1.0000-03	1.0000-11	1.0000+07	4.0000-01
GAMMA	PLGOPT	PLWMIN	PMIN	PRCNT	PRDELT	PRFACT	PRLIM	PROB
0.0000	1.0000+00	2.1000+08	5.0000+06	1.0000-03	0.0000	0.0000	0.0000	3.4000+01
REZ	ROEPS	SIEMIN	STAB	TSTOP				
0.0000	1.0000-05	1.0000+05	1.0000-03	0.0000				

INITIAL CONDITIONS

PACKAGE NUMBER	NORMAL DENSITY (RHOZ)	DENSITY (RHOIN)	S.I.E.	U	V	MATERIAL
1	7.800	7.800	0.0000	0.0000	3.7100+04	IRON
2	2.790	2.790	0.0000	0.0000	0.0000	ALUMINUM
3	2.790	2.790	0.0000	0.0000	0.0000	ALUMINUM

STRENGTH CONSTANTS

PACKAGE NUMBER	CZERO	STK1	STK2	STEZ	RMU	AMDM
1	6.000+09	0.000	0.000	1.300+10	8.000+11	9.700-01
2	3.000+09	0.000	0.000	9.000+09	2.740+11	9.850-01
3	3.000+09	0.000	0.000	9.000+09	2.740+11	9.850-01

I	DR	I	DR	I	DR	I	DR	I	DR	I	DR	I	DR
1	6.517-02	2	6.517-02	3	6.517-02	4	6.517-02	5	6.517-02	6	6.517-02	7	6.517-02
8	6.517-02	9	6.517-02	10	6.517-02	11	7.000-02	12	9.000-02	13	1.200-01	14	1.400-01
15	1.800-01	16	2.300-01	17	2.800-01	18	3.400-01	19	4.000-01	20	4.600-01		

I	R	I	R	I	R	I	R	I	R	I	R	I	R
1	6.517-02	2	1.303-01	3	1.955-01	4	2.607-01	5	3.258-01	6	3.910-01	7	4.562-01
8	5.214-01	9	5.865-01	10	6.517-01	11	7.217-01	12	8.117-01	13	9.317-01	14	1.072+00
15	1.252+00	16	1.482+00	17	1.762+00	18	2.102+00	19	2.502+00	20	2.962+00		

J	DZ	J	DZ	J	DZ	J	DZ	J	DZ	J	DZ	J	DZ
1	6.058-02	2	2.231-01	3	1.962-01	4	1.709-01	5	1.489-01	6	1.298-01	7	1.131-01
8	9.852-02	9	8.584-02	10	7.480-02	11	6.517-02	12	6.517-02	13	6.517-02	14	6.517-02

15	6.517-02	16	6.517-02	17	6.517-02	18	6.517-02	19	6.517-02	20	6.517-02	21	6.517-02
22	6.350-02	23	6.350-02	24	6.350-02	25	6.350-02	26	6.350-02	27	6.350-02	28	6.350-02
29	6.350-02	30	6.350-02	31	6.350-02	32	6.350-02	33	6.350-02	34	6.350-02	35	6.350-02
36	6.350-02	37	6.350-02	38	6.350-02	39	6.350-02	40	6.350-02	41	6.350-02	42	6.350-02
43	6.350-02	44	6.350-02	45	6.350-02	46	6.350+02	47	6.350-02	48	6.350-02	49	6.350-02
50	6.350-02												

J	Z	J	Z	J	Z	J	Z	J	Z	J	Z	J	Z
1	6.050-02	2	2.836-01	3	4.797-01	4	6.507-01	5	7.996-01	6	9.294-01	7	1.042+00
8	1.141+00	9	1.227+00	10	1.302+00	11	1.367+00	12	1.432+00	13	1.497+00	14	1.562+00
15	1.627+00	16	1.693+00	17	1.758+00	18	1.823+00	19	1.888+00	20	1.953+00	21	2.018+00
22	2.082+00	23	2.145+00	24	2.209+00	25	2.272+00	26	2.336+00	27	2.399+00	28	2.463+00
29	2.526+00	30	2.590+00	31	2.653+00	32	2.717+00	33	2.780+00	34	2.844+00	35	2.907+00
36	2.971+00	37	3.034+00	38	3.098+00	39	3.161+00	40	3.225+00	41	3.288+00	42	3.352+00
43	3.415+00	44	3.479+00	45	3.542+00	46	3.606+00	47	3.669+00	48	3.733+00	49	3.796+00
50	3.860+00												

CYCLE 0

CDT 8 27 T= 0.0000000 DT= 2.4098671-10 MAXCUV= 5.2700000+05 MAXUV= 3.7100000+04 UMIN= 5.2700000+00 PMIN= 5.0000000+1

PROBLEM	TIME	CYCLE	TOT.EN.THEOR.	MAX.REL.ERROR-CYCLE		IE SET TO ZERO-PH2	ELASTIC PLASTIC WORK
39.0000	0.0000000	0	5.0919923+09	-1.7596856-07	0	0.0000000	0.0000000

PACKAGE NO.	IE	KE	TOT.EN. (SUM)	MASS	MV	MV(POSITIVE)	MU	PLASTIC-WORK
1	0.0000000	5.0919914+09	5.0919914+09	7.3989455+00	2.7450089+05	2.7450089+05	0.0000000	0.0000000
2	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000	0.0000000
3	0.0000000	0.0000000	0.0000080	4.8821323+01	0.0000000	0.0000000	0.0000000	0.0000000
TOTALS	0.0000000	5.0919914+09	5.0919914+09	5.6220269+01	2.7450089+05	2.7450089+05	0.0000000	0.0000000

	IE OUT	KE OUT
1	0.0000000	0.0000000
2	0.0000000	0.0000000
3	0.0000000	0.0000000

BOUNDARY	BOTTOM	RIGHT	TOP	$EVAPORATED$
MASS OUT	0.0000000	0.0000000	0.0000000	0.0000000
ENERGY OUT	0.0000000	0.0000000	0.0000000	0.0000000
MU OUT	0.0000000	0.0000000	0.0000000	0.0000000
MV OUT	0.0000000	0.0000000	0.0000000	0.0000000
WORK DONE	0.0000000	0.0000000	0.0800000	

DEFINITION OF SLIDE ENDPOINTS

PKG. NO.	MASTER	SLAVE	NBGM	NBGS	NENDM	NENDS
1	0	1	0	102	0	103
2	0	2	0	12	0	32
3	3	0	12	0	32	0

CELL-COORDINATES OF TRACERS FOR EACH MATERIAL PACKAGE

PACKAGE 1

N	X	Y	N	X	Y	N	X	Y	N	X	Y	N	X	Y
1	.00	.99	2	.35	.99	3	.70	.99	4	1.06	.99	5	1.41	.99
6	1.76	.99	7	2.11	.99	8	2.46	.99	9	2.82	.99	10	3.17	.99
11	3.52	.99	12	3.87	.99	13	4.22	.99	14	4.58	.99	15	4.93	.99
16	5.28	.99	17	5.63	.99	18	5.98	.99	19	5.98	.99	20	5.98	1.11
21	5.98	1.23	22	5.98	1.35	23	5.98	1.46	24	5.98	1.58	25	5.98	1.69
26	5.98	1.81	27	5.98	1.93	28	5.98	2.05	29	5.98	2.18	30	5.98	2.31
31	5.98	2.44	32	5.98	2.58	33	5.98	2.71	34	5.98	2.84	35	5.98	2.97
36	5.98	3.12	37	5.98	3.27	38	5.98	3.42	39	5.98	3.57	40	5.98	3.73
41	5.98	3.88	42	5.98	4.03	43	5.98	4.21	44	5.98	4.38	45	5.98	4.56
46	5.98	4.73	47	5.98	4.90	48	5.98	5.09	49	5.98	5.29	50	5.98	5.49
51	5.98	5.69	52	5.98	5.89	53	5.98	6.10	54	5.98	6.33	55	5.98	6.56
56	5.98	6.79	57	5.98	7.82	58	5.98	7.28	59	5.98	7.54	60	5.98	7.81

61	5.98	8.08	62	5.98	8.38	63	5.98	8.68	64	5.98	8.98	65	5.98	9.33
66	5.98	9.67	67	5.98	10.02	68	5.98	10.42	69	5.98	10.82	70	5.98	11.22
71	5.98	11.61	72	5.98	12.01	73	5.98	12.41	74	5.98	12.80	75	5.98	13.20
76	5.98	13.60	77	5.98	14.00	78	5.98	14.39	79	5.98	14.39	80	5.91	14.81
81	5.83	15.22	82	5.76	15.64	83	5.68	16.05	84	5.60	16.47	85	5.53	16.88
86	5.45	17.29	87	5.38	17.71	88	5.30	18.12	89	5.22	18.54	90	5.15	18.95
91	5.07	19.37	92	5.00	19.78	93	4.92	20.19	94	4.84	20.61	95	4.77	21.02
96	4.69	21.45	97	4.62	21.87	98	4.54	22.30	99	4.46	22.72	100	4.39	23.15
101	4.31	23.57	102	4.24	24.00	103	4.24	24.00	104	3.85	24.00	105	3.47	24.00
106	3.08	24.00	107	2.70	24.00	108	2.31	24.00	109	1.93	24.00	110	1.54	24.00
111	1.16	24.00	112	.77	24.00	113	.39	24.00	114	.00	24.00	115	-1000.00	.00

PACKAGE 2

N	X	Y	N	X	Y	N	X	Y	N	X	Y	N	X	Y
1	.00	24.00	2	.39	24.00	3	.77	24.00	4	1.16	24.00	5	1.54	24.00
6	1.93	24.00	7	2.31	24.00	8	2.70	24.00	9	3.08	24.00	10	3.47	24.00
11	3.85	24.00	12	4.24	24.00	13	4.24	24.00	14	4.24	24.00	15	4.24	24.00
16	4.24	24.00	17	4.24	24.00	18	4.24	24.00	19	4.24	24.00	20	4.24	24.00
21	4.24	24.00	22	4.24	24.00	23	4.24	24.00	24	4.24	24.00	25	4.24	24.00
26	4.24	24.00	27	4.24	24.00	28	4.24	24.00	29	4.24	24.00	30	4.24	24.00
31	4.24	24.00	32	4.24	24.00	33	3.85	24.00	34	3.47	24.00	35	3.08	24.00
36	2.70	24.00	37	2.31	24.00	38	1.93	24.00	39	1.54	24.00	40	1.16	24.00
41	.77	24.00	42	.39	24.00	43	.00	24.00	44	-1000.00	.00			

PACKAGE 3

N	X	Y	N	X	Y	N	X	Y	N	X	Y	N	X	Y
1	.00	24.00	2	.39	24.00	3	.77	24.00	4	1.16	24.00	5	1.54	24.00
6	1.93	24.00	7	2.31	24.00	8	2.70	24.00	9	3.08	24.00	10	3.47	24.00
11	3.85	24.00	12	4.24	24.00	13	4.24	24.00	14	4.24	24.00	15	4.24	24.00
16	4.24	24.00	17	4.24	24.00	18	4.24	24.00	19	4.24	24.00	20	4.24	24.00
21	4.24	24.00	22	4.24	24.00	23	4.24	24.00	24	4.24	24.00	25	4.24	24.00
26	4.24	24.00	27	4.24	24.00	28	4.24	24.00	29	4.24	24.00	30	4.24	24.00
31	4.24	24.00	32	4.24	24.00	33	4.62	24.00	34	5.00	24.00	35	5.38	24.00
36	5.77	24.00	37	6.15	24.00	38	6.53	24.00	39	6.92	24.00	40	7.30	24.00
41	7.68	24.00	42	8.07	24.00	43	8.45	24.00	44	8.83	24.00	45	9.22	24.00
46	9.60	24.00	47	9.98	24.00	48	10.34	24.00	49	10.70	24.00	50	11.04	24.00
51	11.32	24.00	52	11.60	24.00	53	11.87	24.00	54	12.11	24.00	55	12.32	24.00
56	12.53	24.00	57	12.74	24.00	58	12.95	24.00	59	13.13	24.00	60	13.31	24.00
61	13.49	24.00	62	13.85	24.00	63	14.44	24.00	64	15.00	24.00	65	15.44	24.00
66	15.87	24.00	67	16.26	24.00	68	16.64	24.00	69	16.97	24.00	70	17.27	24.00
71	17.57	24.00	72	17.87	24.00	73	18.14	24.00	74	18.39	24.00	75	18.64	24.00
76	18.89	24.00	77	19.13	24.00	78	19.34	24.00	79	19.56	24.00	80	19.78	24.00
81	20.00	24.00	82	20.00	34.00	83	19.87	34.00	84	19.74	34.00	85	19.61	34.00
86	19.48	34.00	87	19.34	34.00	88	19.21	34.00	89	19.08	34.00	90	18.94	34.00
91	18.79	34.00	92	18.64	34.00	93	18.49	34.00	94	18.34	34.00	95	18.19	34.00
96	18.04	34.00	97	17.86	34.00	98	17.69	34.00	99	17.51	34.00	100	17.33	34.00
101	17.15	34.00	102	16.97	34.00	103	16.75	34.00	104	16.54	34.00	105	16.32	34.00
106	16.11	34.00	107	15.87	34.00	108	15.60	34.00	109	15.34	34.00	110	15.08	34.00
111	14.76	34.00	112	14.43	34.00	113	14.09	34.00	114	13.69	34.00	115	13.25	34.00
116	12.79	34.00	117	12.29	34.00	118	11.71	34.00	119	11.04	34.00	120	10.19	34.00
121	9.28	34.00	122	8.35	34.00	123	7.42	34.00	124	6.49	34.00	125	5.57	34.00
126	4.64	34.00	127	3.71	34.00	128	2.78	34.00	129	1.86	34.00	130	.93	34.00

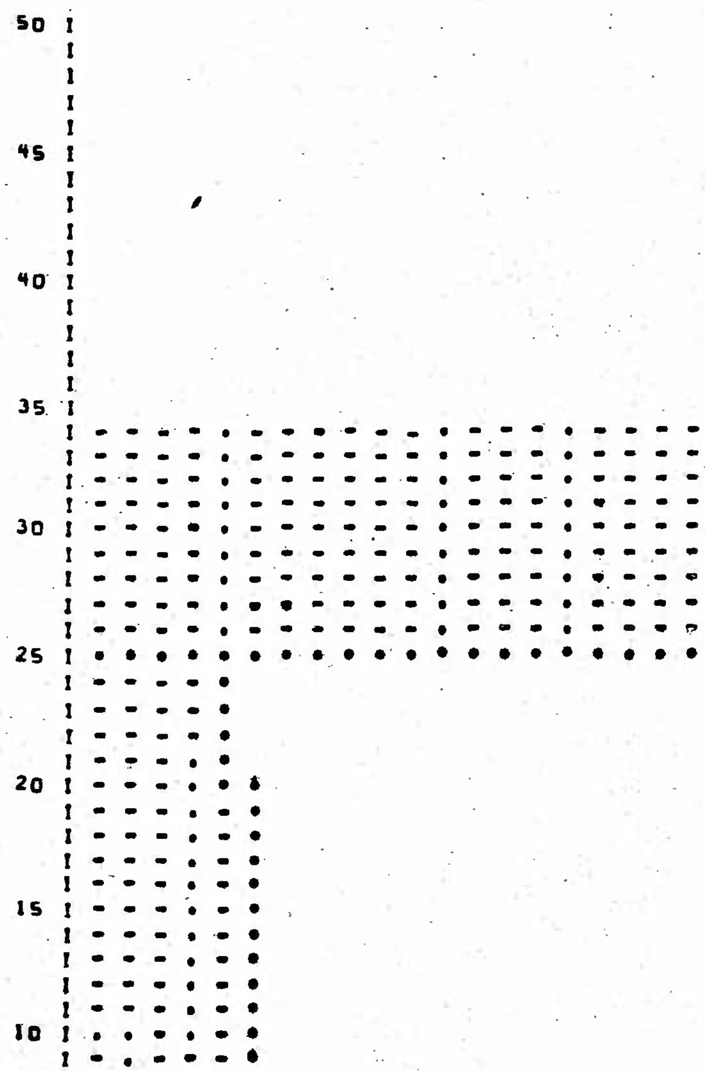
131	.00	34.00	132	-1000.00	.00

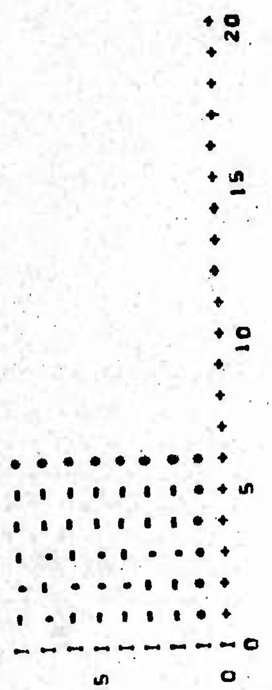
FREE SURFACE TRACERS NVRTEX= 100

N	X	Y	N	X	Y	N	X	Y	N	X	Y	N	X	Y
1	.00	34.00	2	.93	34.00	3	1.86	34.00	4	2.78	34.00	5	3.71	34.00
6	4.64	34.00	7	5.57	34.00	8	6.49	34.00	9	7.42	34.00	10	8.35	34.00
11	9.28	34.00	12	10.19	34.00	13	11.04	34.00	14	11.71	34.00	15	12.29	34.00
16	12.79	34.00	17	13.25	34.00	18	13.69	34.00	19	14.09	34.00	20	14.43	34.00
21	14.76	34.00	22	15.08	34.00	23	15.34	34.00	24	15.60	34.00	25	15.87	34.00
26	16.11	34.00	27	16.32	34.00	28	16.54	34.00	29	16.75	34.00	30	16.97	34.00
31	17.15	34.00	32	17.33	34.00	33	17.51	34.00	34	17.69	34.00	35	17.86	34.00
36	18.04	34.00	37	18.19	34.00	38	18.34	34.00	39	18.49	34.00	40	18.64	34.00
41	18.79	34.00	42	18.94	34.00	43	19.08	34.00	44	19.21	34.00	45	19.34	34.00
46	19.48	34.00	47	19.61	34.00	48	19.74	34.00	49	19.87	34.00	50	20.00	34.00
51	20.00	24.00	52	19.78	24.00	53	19.56	24.00	54	19.34	24.00	55	19.13	24.00
56	18.89	24.00	57	18.64	24.00	58	18.39	24.00	59	18.14	24.00	60	17.87	24.00
61	17.57	24.00	62	17.27	24.00	63	16.97	24.00	64	16.61	24.00	65	16.26	24.00
66	15.87	24.00	67	15.44	24.00	68	15.00	24.00	69	14.44	24.00	70	13.85	24.00
71	13.49	24.00	72	13.31	24.00	73	13.13	24.00	74	12.95	24.00	75	12.74	24.00
76	12.53	24.00	77	12.32	24.00	78	12.11	24.00	79	11.87	24.00	80	11.60	24.00
81	11.32	24.00	82	11.04	24.00	83	10.70	24.00	84	10.34	24.00	85	9.98	24.00
86	9.60	24.00	87	9.22	24.00	88	8.83	24.00	89	8.45	24.00	90	8.07	24.00
91	7.68	24.00	92	7.30	24.00	93	6.92	24.00	94	6.53	24.00	95	6.15	24.00
96	5.77	24.00	97	5.38	24.00	98	5.00	24.00	99	4.62	24.00	100	4.24	24.00
101	4.31	23.57	102	4.39	23.15	103	4.46	22.72	104	4.54	22.30	105	4.62	21.87
106	4.69	21.45	107	4.77	21.02	108	4.84	20.61	109	4.92	20.19	110	5.00	19.78
111	5.07	19.37	112	5.15	18.95	113	5.22	18.54	114	5.30	18.12	115	5.38	17.71
116	5.45	17.29	117	5.53	16.88	118	5.60	16.47	119	5.68	16.05	120	5.76	15.64
121	5.83	15.22	122	5.91	14.81	123	5.98	14.39	124	5.98	14.39	125	5.98	14.00
126	5.98	13.60	127	5.98	13.20	128	5.98	12.80	129	5.98	12.41	130	5.98	12.01
131	5.98	11.61	132	5.98	11.22	133	5.98	10.82	134	5.98	10.42	135	5.98	10.02
136	5.98	9.67	137	5.98	9.33	138	5.98	8.98	139	5.98	8.68	140	5.98	8.38
141	5.98	8.08	142	5.98	7.81	143	5.98	7.54	144	5.98	7.28	145	5.98	7.02
146	5.98	6.79	147	5.98	6.56	148	5.98	6.33	149	5.98	6.10	150	5.98	5.89
151	5.98	5.69	152	5.98	5.49	153	5.98	5.29	154	5.98	5.09	155	5.98	4.96
156	5.98	4.73	157	5.98	4.56	158	5.98	4.38	159	5.98	4.21	160	5.98	4.03
161	5.98	3.88	162	5.98	3.73	163	5.98	3.57	164	5.98	3.42	165	5.98	3.27
166	5.98	3.12	167	5.98	2.97	168	5.98	2.84	169	5.98	2.71	170	5.98	2.58
171	5.98	2.44	172	5.98	2.31	173	5.98	2.18	174	5.98	2.05	175	5.98	1.93
176	5.98	1.81	177	5.98	1.69	178	5.98	1.58	179	5.98	1.46	180	5.98	1.35
181	5.98	1.23	182	5.98	1.11	183	5.98	.99	184	5.98	.99	185	5.63	.99
186	5.28	.99	187	4.93	.99	188	4.58	.99	189	4.22	.99	190	3.87	.99
191	3.52	.99	192	3.17	.99	193	2.82	.99	194	2.46	.99	195	2.11	.99
196	1.76	.99	197	1.41	.99	198	1.06	.99	199	.70	.99	200	.35	.99
201	.00	.99	202	-1000.00	.00									

COMPRESSION CYCLE= 0 TIME= 0.00000 SECONDS

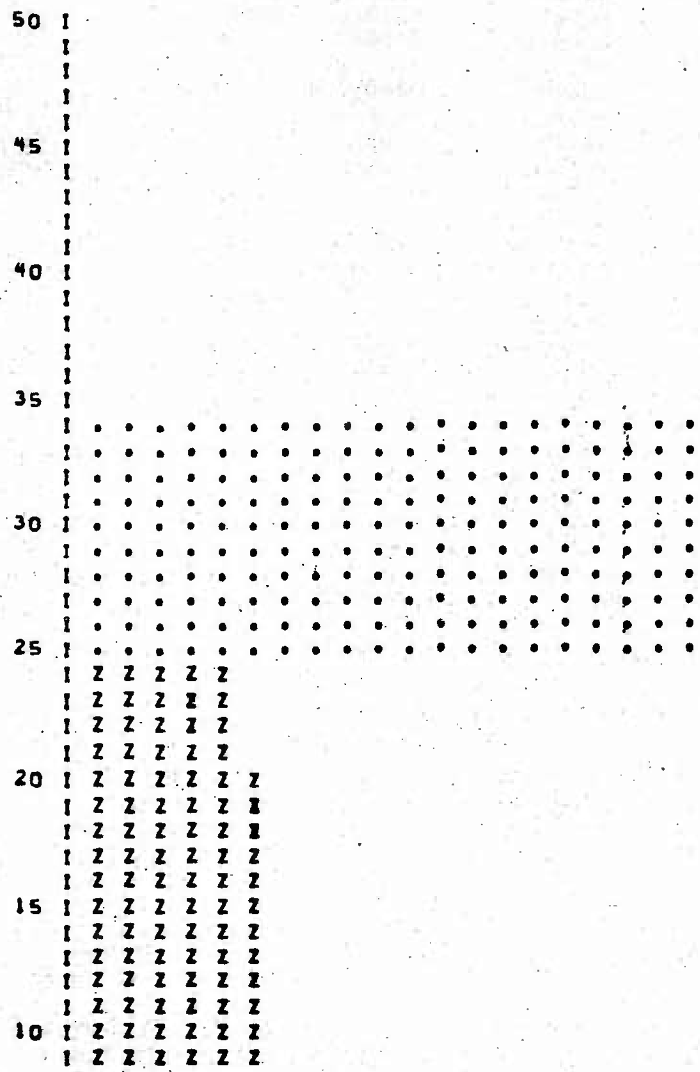
SYMBOL	.	-	A	B	C	D	E	F	G	H
MAXIMUM VALUE	1.000	1.001	1.002	1.003	1.004	1.005	1.006	1.007	1.008	1.009
SYMBOL	I	J	K	L	M	N	O	P	Q	R
MAXIMUM VALUE	1.010	1.011	1.012	1.013	1.014	1.015	1.016	1.017	1.018	1.019
SYMBOL	S	T	U	V	W	X	Y	Z		
MAXIMUM VALUE	1.020	1.021	1.022	1.023	1.024	1.025	1.026	1.027		




0
5
0
5
10
15
20

AXIAL VELOCITY CYCLE= .0 TIME= 0.00000 SECONDS

SYMBOL	.	-	A	B	C	D	E	F	G	H
MAXIMUM VALUE	0.00	1.43+02	1.43+03	2.85+03	4.28+03	5.71+03	7.13+03	8.56+03	9.99+03	1.14+04
SYMBOL	I	J	K	L	M	N	O	P	Q	R
MAXIMUM VALUE	1.28+04	1.43+04	1.57+04	1.71+04	1.86+04	2.00+04	2.14+04	2.28+04	2.43+04	2.57+04
SYMBOL	S	T	U	V	W	X	Y	Z		
MAXIMUM VALUE	2.71+04	2.85+04	3.00+04	3.14+04	3.28+04	3.42+04	3.57+04	3.71+04		



```
     I Z Z Z Z Z Z
     I Z Z Z Z Z Z
     I Z Z Z Z Z Z
   5 I Z Z Z Z Z Z
     I Z Z Z Z Z Z
     I Z Z Z Z Z Z
     I Z Z Z Z Z Z
     I Z Z Z Z Z Z
   0 I + + + + + + + + + + + + + + + + + + + + +
     0         5        10        15        20
```

I = 1   R(I) = 6.5170-02   DR(I) = 6.5170000-02   TAU(I) = 1.3342749-02   T = 0.0000000   CYCLE = 0

J	MFLAG	U	V	P	SIE	COMP	TMASS	SZZ	SRR	SRZ	Z
27	3	0.0000	0.0000	0.0000	0.0000	1.00000+00	2.3639-03	0.0000	0.0000	0.0000	2.399+00
26	3	0.0000	0.0000	0.0000	0.0000	1.00000+00	2.3639-03	0.0000	0.0000	0.0000	2.334+00
25	135	0.0000	0.0000	0.0000	0.0000	0.00000	2.3639-03	0.0000	0.0000	0.0000	2.272+00
	NMAT	US	VS	RHO	SIE	COMP	MASS	FRAC. VOL.	RHO(NVOID)= .0		THETA= -1.00
	3	0.0000	0.0000	7.8000+00	0.0000	1.00000+00	0.0000	0.00000			
	4	0.0000	0.0000	2.7900+00	0.0000	1.00000+00	0.0000	0.00000			
	4	0.0000	0.0000	2.7900+00	0.0000	9.99997-01	2.3639-03	1.00000+00			

J	MFLAG	U	V	P	SIE	COMP	TMASS	SZZ	SRR	SRZ	Z
24	1	0.0000	3.7100+04	0.0000	0.0000	1.00000+00	6.6087-03	0.0000	0.0000	0.0000	2.209+00
23	1	0.0000	3.7100+04	0.0000	0.0000	1.00000+00	6.6087-03	0.0000	0.0000	0.0000	2.145+00
22	1	0.0000	3.7100+04	0.0000	0.0000	1.00000+00	6.6087-03	0.0000	0.0000	0.0000	2.082+00
21	1	0.0000	3.7100+04	0.0000	0.0000	1.00000+00	6.7825-03	0.0000	0.0000	0.0000	2.018+00
20	1	0.0000	3.7100+04	0.0000	0.0000	1.00000+00	6.7825-03	0.0000	0.0000	0.0000	1.953+00
19	1	0.0000	3.7100+04	0.0000	0.0000	1.00000+00	6.7825-03	0.0000	0.0000	0.0000	1.888+00
18	1	0.0000	3.7100+04	0.0000	0.0000	1.00000+00	6.7825-03	0.0000	0.0000	0.0000	1.823+00
17	1	0.0000	3.7100+04	0.0000	0.0000	1.00000+00	6.7825-03	0.0000	0.0000	0.0000	1.758+00
16	1	0.0000	3.7100+04	0.0000	0.0000	1.00000+00	6.7825-03	0.0000	0.0000	0.0000	1.693+00
15	1	0.0000	3.7100+04	0.0000	0.0000	1.00000+00	6.7825-03	0.0000	0.0000	0.0000	1.627+00
14	1	0.0000	3.7100+04	0.0000	0.0000	1.00000+00	6.7825-03	0.0000	0.0000	0.0000	1.562+00
13	1	0.0000	3.7100+04	0.0000	0.0000	1.00000+00	6.7825-03	0.0000	0.0000	0.0000	1.497+00
12	1	0.0000	3.7100+04	0.0000	0.0000	1.00000+00	6.7825-03	0.0000	0.0000	0.0000	1.432+00
11	1	0.0000	3.7100+04	0.0000	0.0000	1.00000+00	6.7825-03	0.0000	0.0000	0.0000	1.367+00
10	1	0.0000	3.7100+04	0.0000	0.0000	1.00000+00	7.7847-03	0.0000	0.0000	0.0000	1.302+00
9	1	0.0000	3.7100+04	0.0000	0.0000	1.00000+00	8.9337-03	0.0000	0.0000	0.0000	1.227+00
8	1	0.0000	3.7100+04	0.0000	0.0000	1.00000+00	1.0253-02	0.0000	0.0000	0.0000	1.141+00
7	1	0.0000	3.7100+04	0.0000	0.0000	1.00000+00	1.1768-02	0.0000	0.0000	0.0000	1.042+00
6	1	0.0000	3.7100+04	0.0000	0.0000	1.00000+00	1.3506-02	0.0000	0.0000	0.0000	9.294-01
5	1	0.0000	3.7100+04	0.0000	0.0000	1.00000+00	1.5501-02	0.0000	0.0000	0.0000	7.996-01
4	1	0.0000	3.7100+04	0.0000	0.0000	1.00000+00	1.7790-02	0.0000	0.0000	0.0000	6.507-01
3	1	0.0000	3.7100+04	0.0000	0.0000	1.00000+00	2.0418-02	0.0000	0.0000	0.0000	4.797-01
2	1	0.0000	3.7100+04	0.0000	0.0000	1.00000+00	2.3215-02	0.0000	0.0000	0.0000	2.836-01
1	101	0.0000	3.7100+04	0.0000	0.0000	0.00000	5.2037-05	0.0000	0.0000	0.0000	6.050-02
	NMAT	US	VS	RHO	SIE	COMP	MASS	FRAC. VOL.	RHO(NVOID)=1.0		THETA= -1.00
	3	0.0000	3.7100+04	7.8000+00	0.0000	1.00000+00	5.2037-05	8.26447-03			
	4	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.00000			
	4	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.00000			

J	MFLAG	U	V	P	SIE	COMP	TMASS	SZZ	SRR	SRZ	Z

I = 2 R(I) = 1.3034-01 DR(I) = 6.5170000-02 TAU(I) = 4.0028248-02 T = 0.0000000 CYCLE = 0

J	MFLAG	U	V	P	SIE	COMP	TMASS	SZZ	SRR	SRZ	Z
27	3	0.0000	0.0000	0.0000	0.0000	1.00000+00	7.0916-03	0.0000	0.0000	0.0000	2.399+
26	3	0.0000	0.0000	0.0000	0.0000	1.00000+00	7.0916-03	0.0000	0.0000	0.0000	2.336+
25	134	0.0000	0.0000	0.0000	0.0000	0.00000	7.0916-03	0.0000	0.0000	0.0000	2.272+

	NMAT	US	VS	RHO	SIE	COMP	MASS	FRAC. VOL.	RHO(NVOID)= .0	THETA= -1.
	3	0.0000	0.0000	7.8000+00	0.0000	1.00000+00	0.0000	0.00000		
	4	0.0000	0.0000	2.7900+00	0.0000	1.00000+00	0.0000	0.00000		
	4	0.0000	0.0000	2.7900+00	0.0000	9.99997-01	7.0916-03	1.00000+00		

J	MFLAG	U	V	P	SIE	COMP	TMASS	SZZ	SRR	SRZ	Z
24	1	0.0000	3.7100+04	0.0000	0.0000	1.00000+00	1.9826-02	0.0000	0.0000	0.0000	2.209+
23	1	0.0000	3.7100+04	0.0000	0.0000	1.00000+00	1.9826-02	0.0000	0.0000	0.0000	2.145+
22	1	0.0000	3.7100+04	0.0000	0.0000	1.00000+00	1.9826-02	0.0000	0.0000	0.0000	2.082+
21	1	0.0000	3.7100+04	0.0000	0.0000	1.00000+00	2.0347-02	0.0000	0.0000	0.0000	2.018+
20	1	0.0000	3.7100+04	0.0000	0.0000	1.00000+00	2.0347-02	0.0000	0.0000	0.0000	1.953+
19	1	0.0000	3.7100+04	0.0000	0.0000	1.00000+00	2.0347-02	0.0000	0.0000	0.0000	1.888+
18	1	0.0000	3.7100+04	0.0000	0.0000	1.00000+00	2.0347-02	0.0000	0.0000	0.0000	1.823+
17	1	0.0000	3.7100+04	0.0000	0.0000	1.00000+00	2.0347-02	0.0000	0.0000	0.0000	1.758+
16	1	0.0000	3.7100+04	0.0000	0.0000	1.00000+00	2.0347-02	0.0000	0.0000	0.0000	1.693+
15	1	0.0000	3.7100+04	0.0000	0.0000	1.00000+00	2.0347-02	0.0000	0.0000	0.0000	1.627+
14	1	0.0000	3.7100+04	0.0000	0.0000	1.00000+00	2.0347-02	0.0000	0.0000	0.0000	1.562+
13	1	0.0000	3.7100+04	0.0000	0.0000	1.00000+00	2.0347-02	0.0000	0.0000	0.0000	1.497+
12	1	0.0000	3.7100+04	0.0000	0.0000	1.00000+00	2.0347-02	0.0000	0.0000	0.0000	1.432+
11	1	0.0000	3.7100+04	0.0000	0.0000	1.00000+00	2.0347-02	0.0000	0.0000	0.0000	1.367+
10	1	0.0000	3.7100+04	0.0000	0.0000	1.00000+00	2.3354-02	0.0000	0.0000	0.0000	1.302+
9	1	0.0000	3.7100+04	0.0000	0.0000	1.00000+00	2.4801-02	0.0000	0.0000	0.0000	1.227+
8	1	0.0000	3.7100+04	0.0000	0.0000	1.00000+00	3.0760-02	0.0000	0.0000	0.0000	1.141+
7	1	0.0000	3.7100+04	0.0000	0.0000	1.00000+00	3.5303-02	0.0000	0.0000	0.0000	1.042+
6	1	0.0000	3.7100+04	0.0000	0.0000	1.00000+00	4.0517-02	0.0000	0.0000	0.0000	9.294-
5	1	0.0000	3.7100+04	0.0000	0.0000	1.00000+00	4.6502-02	0.0000	0.0000	0.0000	7.996-
4	1	0.0000	3.7100+04	0.0000	0.0000	1.00000+00	5.3371-02	0.0000	0.0000	0.0000	6.507-
3	1	0.0000	3.7100+04	0.0000	0.0000	1.00000+00	6.1255-02	0.0000	0.0000	0.0000	4.797-
2	1	0.0000	3.7100+04	0.0000	0.0000	1.00000+00	6.9644-02	0.0000	0.0000	0.0000	2.836-
1	102	0.0000	3.7100+04	0.0000	0.0000	0.00000	1.5611-04	0.0000	0.0000	0.0000	6.050-

	NMAT	US	VS	RHO	SIE	COMP	MASS	FRAC. VOL.	RHO(NVOID)=1.0	THETA= -1.
	3	0.0000	3.7100+04	7.8000+00	0.0000	1.00000+00	1.5611-04	8.26447-03		
	4	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.00000		
	4	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.00000		

J	MFLAG	U	V	P	SIE	COMP	TMASS	SZZ	SRR	SRZ	Z

I = 3 R(I) = 1.9551-01 DR(I) = 6.5170000-02 TAU(I) = 6.6713745-02 T = 0.0000000 CYCLE = 0

J	MFLAG	U	V	P	SIE	COMP	TMASS	SZZ	SRR	SRZ	Z
27	3	0.0000	0.0000	0.0000	0.0000	1.00000+00	1.1819-02	0.0000	0.0000	0.0000	2.399+00
26	3	0.0000	0.0000	0.0000	0.0000	1.00000+00	1.1819-02	0.0000	0.0000	0.0000	2.336+00
25	133	0.0000	0.0000	0.0000	0.0000	0.00000	1.1819-02	0.0000	0.0000	0.0000	2.272+00

NMAT	US	VS	RHO	SIE	COMP	MASS	FRAC. VOL.	RHO(NVOID)= .0 THETA= -1.00
3	0.0000	0.0000	7.8000+00	0.0000	1.00000+00	0.0000	0.00000	
4	0.0000	0.0000	2.7900+00	0.0000	1.00000+00	0.0000	0.00000	
4	0.0000	0.0000	2.7900+00	0.0000	9.99997-01	1.1819-02	1.00000+00	

J	MFLAG	U	V	P	SIE	COMP	TMASS	SZZ	SRR	SRZ	Z
24	1	0.0000	3.7100+04	0.0000	0.0000	1.00000+00	3.3043-02	0.0000	0.0000	0.0000	2.209+00
23	1	0.0000	3.7100+04	0.0000	0.0000	1.00000+00	3.3043-02	0.0000	0.0000	0.0000	2.148+00
22	1	0.0000	3.7100+04	0.0000	0.0000	1.00000+00	3.3043-02	0.0000	0.0000	0.0000	2.082+00
21	1	0.0000	3.7100+04	0.0000	0.0000	1.00000+00	3.3912-02	0.0000	0.0000	0.0000	2.018+00
20	1	0.0000	3.7100+04	0.0000	0.0000	1.00000+00	3.3912-02	0.0000	0.0000	0.0000	1.953+00
19	1	0.0000	3.7100+04	0.0000	0.0000	1.00000+00	3.3912-02	0.0000	0.0000	0.0000	1.888+00
18	1	0.0000	3.7100+04	0.0000	0.0000	1.00000+00	3.3912-02	0.0000	0.0000	0.0000	1.823+00
17	1	0.0000	3.7100+04	0.0000	0.0000	1.00000+00	3.3912-02	0.0000	0.0000	0.0000	1.758+00
16	1	0.0000	3.7100+04	0.0000	0.0000	1.00000+00	3.3912-02	0.0000	0.0000	0.0000	1.693+00
15	1	0.0000	3.7100+04	0.0000	0.0000	1.00000+00	3.3912-02	0.0000	0.0000	0.0000	1.627+00
14	1	0.0000	3.7100+04	0.0000	0.0000	1.00000+00	3.3912-02	0.0000	0.0000	0.0000	1.562+00
13	1	0.0000	3.7100+04	0.0000	0.0000	1.00000+00	3.3912-02	0.0000	0.0000	0.0000	1.497+00
12	1	0.0000	3.7100+04	0.0000	0.0000	1.00000+00	3.3912-02	0.0000	0.0000	0.0000	1.432+00
11	1	0.0000	3.7100+04	0.0000	0.0000	1.00000+00	3.3912-02	0.0000	0.0000	0.0000	1.367+00
10	1	0.0000	3.7100+04	0.0000	0.0000	1.00000+00	3.8923-02	0.0000	0.0000	0.0000	1.302+00
9	1	0.0000	3.7100+04	0.0000	0.0000	1.00000+00	4.4668-02	0.0000	0.0000	0.0000	1.227+00
8	1	0.0000	3.7100+04	0.0000	0.0000	1.00000+00	5.1267-02	0.0000	0.0000	0.0000	1.141+00
7	1	0.0000	3.7100+04	0.0000	0.0000	1.00000+00	5.8838-02	0.0000	0.0000	0.0000	1.042+00
6	1	0.0000	3.7100+04	0.0000	0.0000	1.00000+00	6.7528-02	0.0000	0.0000	0.0000	[illegible]
5	1	0.0000	3.7100+04	0.0000	0.0000	1.00000+00	7.7503-02	0.0000	0.0000	0.0000	7.996-01
4	1	0.0000	3.7100+04	0.0000	0.0000	1.00000+00	8.8952-02	0.0000	0.0000	0.0000	6.507-01
3	1	0.0000	3.7100+04	0.0000	0.0000	1.00000+00	1.0209-01	0.0000	0.0000	0.0000	4.797-01
2	1	0.0000	3.7100+04	0.0000	0.0000	1.00000+00	1.1607-01	0.0000	0.0000	0.0000	2.836-01
1	103	0.0000	3.7100+04	0.0000	0.0000	0.00000	2.6018-04	0.0000	0.0000	0.0000	6.050-02

NMAT	US	VS	RHO	SIE	COMP	MASS	FRAC. VOL.	RHO(NVOID)=1.0 THETA= -1.00
3	0.0000	3.7100+04	7.8000+00	0.0000	1.00000+00	2.6018-04	8.26447-03	
4	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.90000	
4	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.80000	

J	MFLAG	U	V	P	SIE	COMP	TMASS	SZZ	SRR	SRZ	Z

I = 4 R(I) = 2.6068-01 DR(I) = 6.5170000-02 TAU(I) = 9.3399240-02 T = 0.0000000 CYCLE = 0

J	MFLAG	U	V	P	SIE	COMP	TMASS	SZZ	SRR	SRZ	Z
27	3	0.0000	0.0000	0.0000	0.0000	1.00000+00	1.6547-02	0.0000	0.0000	0.0000	2.399+00
26	3	0.0000	0.0000	0.0000	0.0000	1.00000+00	1.6547-02	0.0000	0.0000	0.0000	2.336+00
25	132	0.0000	0.0000	0.0000	0.0000	0.00000	1.6547-02	0.0000	0.0000	0.0000	2.272+00

NMAT	US	VS	RHO	SIE	COMP	MASS	FRAC. VOL.	RHO(NVOID)= .0 THETA= -1.00
3	0.0000	0.0000	7.8000+00	0.0000	1.00000+00	0.0000	0.00000	

```
        4   0.0000     0.0000     2.7900+00  0.0000     1.00000+00  0.0000     0.00000
        4   0.0000     0.0000     2.7900+00  0.0000     9.99998-01  1.6547-02  1.00000+00

 J  MFLAG   U          V          P          SIE        COMP        TMASS      SZZ        SRR        SRZ        Z

24     1    0.0000     3.7100+04  0.0000     0.0000     1.00000+00  4.6261-02  0.0000     0.0000     0.0000     2.209+00
23     1    0.0000     3.7100+04  0.0000     0.0000     1.00000+00  4.6261-02  0.0000     0.0000     0.0000     2.145+00
22     1    0.0000     3.7100+04  0.0000     0.0000     1.00000+00  4.6261-02  0.0000     0.0000     0.0000     2.082+00
21     1    0.0000     3.7100+04  0.0000     0.0000     1.00000+00  4.7477-02  0.0000     0.0000     0.0000     2.018+00
20     1    0.0000     3.7100+04  0.0000     0.0000     1.00000+00  4.7477-02  0.0000     0.0000     0.0000     1.953+00
19     1    0.0000     3.7100+04  0.0000     0.0000     1.00000+00  4.7477-02  0.0000     0.0000     0.0000     1.888+00
18     1    0.0000     3.7100+04  0.0000     0.0000     1.00000+00  4.7477-02  0.0000     0.0000     0.0000     1.823+00
17     1    0.0000     3.7100+04  0.0000     0.0000     1.00000+00  4.7477-02  0.0000     0.0000     0.0000     1.758+00
16     1    0.0000     3.7100+04  0.0000     0.0000     1.00000+00  4.7477-02  0.0000     0.0000     0.0000     1.693+00
15     1    0.0000     3.7100+04  0.0000     0.0000     1.00000+00  4.7477-02  0.0000     0.0000     0.0000     1.627+00
14     1    0.0000     3.7100+04  0.0000     0.0000     1.00000+00  4.7477-02  0.0000     0.0000     0.0000     1.562+00
13     1    0.0000     3.7100+04  0.0000     0.0000     1.00000+00  4.7477-02  0.0000     0.0000     0.0000     1.497+00
12     1    0.0000     3.7100+04  0.0000     0.0000     1.00000+00  4.7477-02  0.0000     0.0000     0.0000     1.432+00
11     1    0.0000     3.7100+04  0.0000     0.0000     1.00000+00  4.7477-02  0.0000     0.0000     0.0000     1.367+00
10     1    0.0000     3.7100+04  0.0000     0.0000     1.00000+00  5.4493-02  0.0000     0.0000     0.0000     1.302+00
 9     1    0.0000     3.7100+04  0.0000     0.0000     1.00000+00  6.2536-02  0.0000     0.0000     0.0000     1.227+00
 8     1    0.0000     3.7100+04  0.0000     0.0000     1.00000+00  7.1773-02  0.0000     0.0000     0.0000     1.141+00
 7     1    0.0000     3.7100+04  0.0000     0.0000     1.00000+00  8.2373-02  0.0000     0.0000     0.0000     1.042+00
 6     1    0.0000     3.7100+04  0.0000     0.0000     1.00000+00  9.4539-02  0.0000     0.0000     0.0000     9.294-01
 5     1    0.0000     3.7100+04  0.0000     0.0000     1.00000+00  1.0850-01  0.0000     0.0000     0.0000     7.996-01
 4     1    0.0000     3.7100+04  0.0000     0.0000     1.00000+00  1.2453-01  0.0000     0.0000     0.0000     6.507-01
 3     1    0.0000     3.7100+04  0.0000     0.0000     1.00000+00  1.4293-01  0.0000     0.0000     0.0000     4.797-01
 2     1    0.0000     3.7100+04  0.0000     0.0000     1.00000+00  1.6260-01  0.0000     0.0000     0.0000     2.836-01
 1   104    0.0000     3.7100+04  0.0000     0.0000     0.00000     3.6426-04  0.0000     0.0000     0.0000     6.050-02
    NMAT    US         VS         RHO        SIE        COMP        MASS       FRAC. VOL.  RHO(NVOID)=1.0  THETA= -1.00
       3    0.0000     3.7100+04  7.8000+00  0.0000     1.00000+00  3.6426-04  8.26447-03
       4    0.0000     0.0000     0.0000     0.0000     0.00000     0.0000     0.00000
       4    0.0000     0.0000     0.0000     0.0000     0.00000     0.0000     0.00000

 J  MFLAG   U          V          P          SIE        COMP        TMASS      SZZ        SRR        SRZ        Z

---------------------------------------------------------------------------------------------------------------------
I =  5      R(I) = 3.2585-01      DR(I) = 6.5170000-02      TAU(I) = 1.2008474-01      T = 0.0000000      CYCLE =   0
---------------------------------------------------------------------------------------------------------------------

 J  MFLAG   U          V          P          SIE        COMP        TMASS      SZZ        SRR        SRZ        Z

27     3    0.0000     0.0000     0.0000     0.0000     1.00000+00  2.1275-02  0.0000     0.0000     0.0000     2.399+00
26     3    0.0000     0.0000     0.0000     0.0000     1.00000+00  2.1275-02  0.0000     0.0000     0.0000     2.336+00
25   131    0.0000     0.0000     0.0000     0.0000     0.00000     2.1275-02  0.0000     0.0000     0.0000     2.272+00
    NMAT    US         VS         RHO        SIE        COMP        MASS       FRAC. VOL.  RHO(NVOID)=1.0  THETA= -1.00
       3    0.0000     0.0000     7.8000+00  0.0000     1.00000+00  0.0000     0.00000
       4    0.0000     0.0000     2.7900+00  0.0000     1.00000+00  0.0000     0.00000
       4    0.0000     0.0000     2.7900+00  0.0000     1.00000+00  2.1275-02  9.99998-01

 J  MFLAG   U          V          P          SIE        COMP        TMASS      SZZ        SRR        SRZ        Z

24   130    0.0000     3.7100+04  0.0000     0.0000     0.00000     1.7870-02  0.0000     0.0000     0.0000     2.209+00
    NMAT    US         VS         RHO        SIE        COMP        MASS       FRAC. VOL.  RHO(NVOID)=1.0  THETA= -1.00
```

```
        3    0.0000      3.7100+04   7.8000+00   0.0000     1.00000+00   1.7870-02   3.00453-01
        4    0.0000      0.0000      0.0000      0.0000     0.00000      0.0000      0.00000
        4    0.0000      0.0000      2.7900+00   0.0000     1.00000+00   0.0000      0.00000

  J  MFLAG     U           V           P          SIE        COMP        TMASS        SZZ          SRR          SRZ          Z

 23   129    0.0000      3.7100+04   0.0000      0.0000     0.00000      2.8306-02   0.0000       0.0000       0.0000      2.145+00
      NMAT     US          VS          RHO        SIE        COMP         MASS      FRAC. VOL.    RHO(NVOID)=1.0   THETA= -1.00
        3    0.0000      3.7100+04   7.8000+00   0.0000     1.00000+00   2.8306-02   4.75903-01
        4    0.0000      0.0000      0.0000      0.0000     0.00000      0.0000      0.00000
        4    0.0000      0.0000      0.0000      0.0000     0.00000      0.0000      0.00000

  J  MFLAG     U           V           P          SIE        COMP        TMASS        SZZ          SRR          SRZ          Z

 22   128    0.0000      3.7100+04   0.0000      0.0000     0.00000      3.9164-02   0.0000       0.0000       0.0000      2.082+00
      NMAT     US          VS          RHO        SIE        COMP         MASS      FRAC. VOL.    RHO(NVOID)=1.0   THETA= -1.00
        3    0.0000      3.7100+04   7.8000+00   0.0000     1.00000+00   3.9164-02   6.58464-01
        4    0.0000      0.0000      0.0000      0.0000     0.00000      0.0000      0.00000
        4    0.0000      0.0000      0.0000      0.0000     0.00000      0.0000      0.00000

  J  MFLAG     U           V           P          SIE        COMP        TMASS        SZZ          SRR          SRZ          Z

 21   127    0.0000      3.7100+04   0.0000      0.0000     0.00000      5.1928-02   0.0000       0.0000       0.0000      2.018+00
      NMAT     US          VS          RHO        SIE        COMP         MASS      FRAC. VOL.    RHO(NVOID)=1.0   THETA= -1.00
        3    0.0000      3.7100+04   7.8000+00   0.0000     1.00000+00   5.1928-02   8.50691-01
        4    0.0000      0.0000      0.0000      0.0000     0.00000      0.0000      0.00000
        4    0.0000      0.0000      0.0000      0.0000     0.00000      0.0000      0.00000

  J  MFLAG     U           V           P          SIE        COMP        TMASS        SZZ          SRR          SRZ          Z

 20   126    0.0000      3.7100+04   0.0000      0.0000     0.00000      6.0674-02   0.0000       0.0000       0.0000      1.953+00
      NMAT     US          VS          RHO        SIE        COMP         MASS      FRAC. VOL.    RHO(NVOID)=1.0   THETA= -1.00
        3    0.0000      3.7100+04   7.8000+00   0.0000     1.00000+00   6.0674-02   9.93962-01
        4    0.0000      0.0000      0.0000      0.0000     0.00000      0.0000      0.00000
        4    0.0000      0.0000      0.0000      0.0000     0.00000      0.0000      0.00000

  J  MFLAG     U           V           P          SIE        COMP        TMASS        SZZ          SRR          SRZ          Z

 19     1    0.0000      3.7100+04   0.0000      0.0000     1.00000+00   6.1042-02   0.0000       0.0000       0.0000      1.888+00
 18     1    0.0000      3.7100+04   0.0000      0.0000     1.00000+00   6.1042-02   0.0000       0.0000       0.0000      1.823+00
 17     1    0.0000      3.7100+04   0.0000      0.0000     1.00000+00   6.1042-02   0.0000       0.0000       0.0000      1.758+00
 16     1    0.0000      3.7100+04   0.0000      0.0000     1.00000+00   6.1042-02   0.0000       0.0000       0.0000      1.693+00
 15     1    0.0000      3.7100+04   0.0000      0.0000     1.00000+00   6.1042-02   0.0000       0.0000       0.0000      1.627+00
 14     1    0.0000      3.7100+04   0.0000      0.0000     1.00000+00   6.1042-02   0.0000       0.0000       0.0000      1.562+00
 13     1    0.0000      3.7100+04   0.0000      0.0000     1.00000+00   6.1042-02   0.0000       0.0000       0.0000      1.497+00
 12     1    0.0000      3.7100+04   0.0000      0.0000     1.00000+00   6.1042-02   0.0000       0.0000       0.0000      1.432+00
 11     1    0.0000      3.7100+04   0.0000      0.0000     1.00000+00   6.1042-02   0.0000       0.0000       0.0000      1.367+00
 10     1    0.0000      3.7100+04   0.0000      0.0000     1.00000+00   7.0062-02   0.0000       0.0000       0.0000      1.302+00
  9     1    0.0000      3.7100+04   0.0000      0.0000     1.00000+00   8.0403-02   0.0000       0.0000       0.0000      1.227+00
  8     1    0.0000      3.7100+04   0.0000      0.0000     1.00000+00   9.2280-02   0.0000       0.0000       0.0000      1.141+00
  7     1    0.0000      3.7100+04   0.0000      0.0000     1.00000+00   1.0591-01   0.0000       0.0000       0.0000      1.042+00
  6     1    0.0000      3.7100+04   0.0000      0.0000     1.00000+00   1.2155-01   0.0000       0.0000       0.0000      9.294-01
  5     1    0.0000      3.7100+04   0.0000      0.0000     1.00000+00   1.3951-01   0.0000       0.0000       0.0000      7.996-01
  4     1    0.0000      3.7100+04   0.0000      0.0000     1.00000+00   1.6011-01   0.0000       0.0000       0.0000      6.507-01
```

```
  3    1   0.0000    3.7100+04   0.0000   0.0000   1.00000+00   1.8376-01   0.0000       0.0000     0.0000     4.737-03
  2    1   0.0000    3.7100+04   0.0000   0.0000   1.00000+00   2.0893-01   0.0000       0.0000     0.0000     2.836-01
  1  105   0.0000    3.7100+04   0.0000   0.0000   0.00000      4.6833-04   0.0000       0.0000     0.0000     6.050-02
    NMAT     US          VS        RHO      SIE       COMP         MASS      FRAC. VOL.    RHO(NVOID)=1.0   THETA= -1.00
       3   0.0000    3.7100+04   7.8000+00  0.0000   1.00000+00   4.6833-04   8.26447-03
       4   0.0000    0.0000      0.0000   0.0000   0.00000      0.0000       0.00000
       4   0.0000    0.0000      0.0000   0.0000   0.00000      0.0000       0.00000

 J  MFLAG    U           V          P        SIE       COMP        TMASS        SZZ          SRR        SRZ          Z

-------------------------------------------------------------------------------------------------------------------------
 I = 6      R(I) = 3.9102-01     DR(I) = 6.5170000-02     TAU(I) = 1.4677023-01     T = 0.0000000     CYCLE =   0
-------------------------------------------------------------------------------------------------------------------------

 J  MFLAG    U           V          P        SIE       COMP        TMASS        SZZ          SRR        SRZ          Z

 27    3   0.0000    0.0000      0.0000   0.0000   1.00000+00   2.6003-02   0.0000       0.0000     0.0000     2.399+00
 26    3   0.0000    0.0000      0.0000   0.0000   1.00000+00   2.6003-02   0.0000       0.0000     0.0000     2.336+00
 25  136   0.0000    0.0000      0.0000   0.0000   0.00000      2.6002-02   0.0000       0.0000     0.0000     2.272+00
    NMAT     US          VS        RHO      SIE       COMP         MASS      FRAC. VOL.    RHO(NVOID)=1.0   THETA= -1.00
       3   0.0000    0.0000      0.0000   0.0000   0.00000      0.0000       0.00000
       4   0.0000    0.0000      0.0000   0.0000   0.00000      0.0000       0.00000
       4   0.0000    0.0000      2.7900+00  0.0000   1.00000+00   2.6002-02   9.99997-01

 J  MFLAG    U           V          P        SIE       COMP        TMASS        SZZ          SRR        SRZ          Z

 24    0   0.0000    0.0000      0.0000   0.0000   0.00000      0.0000       0.0000       0.0000     0.0000     2.209+00
 23    0   0.0000    0.0000      0.0000   0.0000   0.00000      0.0000       0.0000       0.0000     0.0000     2.145+00
 22    0   0.0000    0.0000      0.0000   0.0000   0.00000      0.0000       0.0000       0.0000     0.0000     2.082+00
 21    0   0.0000    0.0000      0.0000   0.0000   0.00000      0.0000       0.0000       0.0000     0.0000     2.018+00
 20  125   0.0000    3.7100+04   0.0000   0.0000   0.00000      3.5940-03    0.0000       0.0000     0.0000     1.953+00
    NMAT     US          VS        RHO      SIE       COMP         MASS      FRAC. VOL.    RHO(NVOID)=1.0   THETA= -1.00
       3   0 0000    3 7100+04   7 8000+00  0 0000   1 00000 00   3.5940-03    4 81718-02
       4   0.0000    0.0000      0.0000   0.0000   0.00000      0.0000       0.00000
       4   0.0000    0.0000      0.0000   0.0000   0.00000      0.0000       0.00000

 J  MFLAG    U           V          P        SIE       COMP        TMASS        SZZ          SRR        SRZ          Z

 19  124   0.0000    3.7100+04   0.0000   0.0000   0.00000      1.6022-02   0.0000       0.0000     0.0000     1.888+00
    NMAT     US          VS        RHO      SIE       COMP         MASS      FRAC. VOL.    RHO(NVOID)=1.0   THETA= -1.00
       3   0.0000    3.7100+04   7.8000+00  0.0000   1.00000+00   1.6022-02   2.14752-01
       4   0.0000    0.0000      0.0000   0.0000   0.00000      0.0000       0.00000
       4   0.0000    0.0000      0.0000   0.0000   0.00000      0.0000       0.00000

 J  MFLAG    U           V          P        SIE       COMP        TMASS        SZZ          SRR        SRZ          Z

 18  123   0.0000    3.7100+04   0.0000   0.0000   0.00000      2.9276-02   0.0000       0.0000     0.0000     1.823+00
    NMAT     US          VS        RHO      SIE       COMP         MASS      FRAC. VOL.    RHO(NVOID)=1.0   THETA= -1.00
       3   0.0000    3.7100+04   7.8000+00  0.0000   1.00000+00   2.9276-02   3.92399-01
       4   0.0000    0.0000      0.0000   0.0000   0.00000      0.0000       0.00000
       4   0.0000    0.0000      0.0000   0.0000   0.00000      0.0000       0.00000

 J  MFLAG    U           V          P        SIE       COMP        TMASS        SZZ          SRR        SRZ          Z
```

```
17  122    0.0000      3.7100+04   0.0000    0.0000    0.00000      4.2987-02   0.0000      0.0000      0.0000     1.758+00
    NMAT    US          VS          RHO       SIE       COMP         MASS      FRAC. VOL.   RHO(NVOID)=1.0  THETA= -1.00
       3   0.0000      3.7100+04   7.8000+00  0.0000    1.00000+00   4.2987-02   5.76174-01
       4   0.0000      0.0000      0.0000    0.0000    0.00000      0.0000      0.00000
       4   0.0000      0.0000      0.0000    0.0000    0.00000      0.0000      0.00000

 J  MFLAG    U           V           P         SIE       COMP         TMASS       SZZ         SRR         SRZ         Z

16  121    0.0000      3.7100+04   0.0000    0.0000    0.00000      5.7155-02   0.0000      0.0000      0.0000     1.693+00
    NMAT    US          VS          RHO       SIE       COMP         MASS      FRAC. VOL.   RHO(NVOID)=1.0  THETA= -1.00
       3   0.0000      3.7100+04   7.8000+00  0.0000    1.00000+00   5.7155-02   7.66076-01
       4   0.0000      0.0000      0.0000    0.0000    0.00000      0.0000      0.00000
       4   0.0000      0.0000      0.0000    0.0000    0.00000      0.0000      0.00000

 J  MFLAG    U           V           P         SIE       COMP         TMASS       SZZ         SRR         SRZ         Z

15  120    0.0000      3.7100+04   0.0000    0.0000    0.00000      7.0617-02   0.0000      0.0000      0.0000     1.627+00
    NMAT    US          VS          RHO       SIE       COMP         MASS      FRAC. VOL.   RHO(NVOID)=1.0  THETA= -1.00
       3   0.0000      3.7100+04   7.8000+00  0.0000    1.00000+00   7.0617-02   9.46523-01
       4   0.0000      0.0000      0.0000    0.0000    0.00000      0.0000      0.00000
       4   0.0000      0.0000      0.0000    0.0000    0.00000      0.0000      0.00000

 J  MFLAG    U           V           P         SIE       COMP         TMASS       SZZ         SRR         SRZ         Z

14  119    0.0000      3.7100+04   0.0000    0.0000    0.00000      7.3335-02   0.0000      0.0000      0.0000     1.562+00
    NMAT    US          VS          RHO       SIE       COMP         MASS      FRAC. VOL.   RHO(NVOID)=1.0  THETA= -1.00
       3   0.0000      3.7100+04   7.8000+00  0.0000    1.00000+00   7.3335-02   9.82948-01
       4   0.0000      0.0000      0.0000    0.0000    0.00000      0.0000      0.00000
       4   0.0000      0.0000      0.0000    0.0000    0.00000      0.0000      0.00000

 J  MFLAG    U           V           P         SIE       COMP         TMASS       SZZ         SRR         SRZ         Z

13  118    0.0000      3.7100+04   0.0000    0.0000    0.00000      7.3335-02   0.0000      0.0000      0.0000     1.497+00
    NMAT    US          VS          RHO       SIE       COMP         MASS      FRAC. VOL.   RHO(NVOID)=1.0  THETA= -1.00
       3   0.0000      3.7100+04   7.8000+00  0.0000    1.00000+00   7.3335-02   9.82948-01
       4   0.0000      0.0000      0.0000    0.0000    0.00000      0.0000      0.00000
       4   0.0000      0.0000      0.0000    0.0000    0.00000      0.0000      0.00000

 J  MFLAG    U           V           P         SIE       COMP         TMASS       SZZ         SRR         SRZ         Z

12  117    0.0000      3.7100+04   0.0000    0.0000    0.00000      7.3335-02   0.0000      0.0000      0.0000     1.432+00
    NMAT    US          VS          RHO       SIE       COMP         MASS      FRAC. VOL.   RHO(NVOID)=1.0  THETA= -1.00
       3   0.0000      3.7100+04   7.8000+00  0.0000    1.00000+00   7.3335-02   9.82948-01
       4   0.0000      0.0000      0.0000    0.0000    0.00000      0.0000      0.00000
       4   0.0000      0.0000      0.0000    0.0000    0.00000      0.0000      0.00000

 J  MFLAG    U           V           P         SIE       COMP         TMASS       SZZ         SRR         SRZ         Z

11  116    0.0000      3.7100+04   0.0000    0.0000    0.00000      7.3335-02   0.0000      0.0000      0.0000     1.367+00
    NMAT    US          VS          RHO       SIE       COMP         MASS      FRAC. VOL.   RHO(NVOID)=1.0  THETA= -1.00
       3   0.0000      3.7100+04   7.8000+00  0.0000    1.00000+00   7.3335-02   9.82948-01
       4   0.0000      0.0000      0.0000    0.0000    0.00000      0.0000      0.00000
       4   0.0000      0.0000      0.0000    0.0000    0.00000      0.0000      0.00000
```

```
 J  MFLAG     U          V           P          SIE        COMP         TMASS       SZZ          SRR         SRZ          Z

10   115    0.0000    3.7100+04    0.0000     0.0000     0.00000     8.4171-02   0.0000       0.0000      0.0000     1.302+00
    NMAT      US         VS          RHO        SIE        COMP         MASS      FRAC. VOL.     RHO(NVOID)=1.0   THETA= -1.00
      3     0.0000    3.7100+04    7.8000+00  0.0000     1.00000+00  8.4171-02    9.82948-01
      4     0.0000    0.0000       0.0000     0.0000     0.00000     0.0000       0.00000
      4     0.0000    0.0000       0.0000     0.0000     0.00000     0.0000       0.00000

 J  MFLAG     U          V           P          SIE        COMP         TMASS       SZZ          SRR         SRZ          Z

 9   114    0.0000    3.7100+04    0.0000     0.0000     0.00000     9.4595-02   0.0000       0.0000      0.0000     1.227+00
    NMAT      US         VS          RHO        SIE        COMP         MASS      FRAC. VOL.     RHO(NVOID)=1.0   THETA= -1.00
      3     0.0000    3.7100+04    7.8000+00  0.0000     1.00000+00  9.4595-02    9.82948-01
      4     0.0000    0.0000       0.0000     0.0000     0.00000     0.0000       0.00000
      4     0 0000    0 0000       0 0000     0 0000     0 00000     0.0000       0 00000

 J  MFLAG     U          V           P          SIE        COMP         TMASS       SZZ          SRR         SRZ          Z

 8   113    0.0000    3.7100+04    0.0000     0.0000     0.00000     1.1086-01   0.0000       0.0000      0.0000     1.141+00
    NMAT      US         VS          RHO        SIE        COMP         MASS      FRAC. VOL.     RHO(NVOID)=1.0   THETA= -1.00
      3     0.0000    3.7100+04    7.8000+00  0.0000     1.00000+00  1.1086-01    9.82948-01
      4     0.0000    0.0000       0.0000     0.0000     0.00000     0.0000       0.00000
      4     0.0000    0.0000       0.0000     0.0000     0.00000     0.0000       0.00000

 J  MFLAG     U          V           P          SIE        COMP         TMASS       SZZ          SRR         SRZ          Z

 7   112    0.0000    3.7100+04    0.0000     0.0000     0.00000     1.2724-01   0.0000       0.0000      0.0000     1.042+00
    NMAT      US         VS          RHO        SIE        COMP         MASS      FRAC. VOL.     RHO(NVOID)=1.0   THETA= -1.00
      3     0.0000    3.7100+04    7.8000+00  0.0000     1.00000+00  1.2724-01    9.82948-01
      4     0.0000    0.0000       0.0000     0.0000     0.00000     0.0000       0.00000
      4     0.0000    0.0000       0.0000     0.0000     0.00000     0.0000       0.00000

 J  MFLAG     U          V           P          SIE        COMP         TMASS       SZZ          SRR         SRZ          Z

 6   111    0.0000    3.7100+04    0.0000     0.0000     0.00000     1.4603-01   0.0000       0.0000      0.0000     9.294-01
    NMAT      US         VS          RHO        SIE        COMP         MASS      FRAC. VOL.     RHO(NVOID)=1.0   THETA= -1.00
      3     0.0000    3.7100+04    7.8000+00  0.0000     1.00000+00  1.4603-01    9.82948-01
      4     0.0000    0.0000       0.0000     0.0000     0.00000     0.0000       0.00000
      4     0.0000    0.0000       0.0000     0.0000     0.00000     0.0000       0.00000

 J  MFLAG     U          V           P          SIE        COMP         TMASS       SZZ          SRR         SRZ          Z

 5   110    0 0000    3 7100+04    0 0000     0 0000     0 00000     1.6760-01   0.0000       0.0000      0.0000     7.996-01
    NMAT      US         VS          RHO        SIE        COMP         MASS      FRAC. VOL.     RHO(NVOID)=1.0   THETA= -1.00
      3     0.0000    3.7100+04    7.8000+00  0.0000     1.00000+00  1.6760-01    9.82948-01
      4     0.0000    0.0000       0.0000     0.0000     0.00000     0.0000       0.00000
      4     0.0000    0.0000       0.0000     0.0000     0.00000     0.0000       0.00000

 J  MFLAG     U          V           P          SIE        COMP         TMASS       SZZ          SRR         SRZ          Z

 4   109    0.0000    3.7100+04    0.0000     0.0000     0.00000     1.9236-01   0.0000       0.0000      0.0000     6.507-01
    NMAT      US         VS          RHO        SIE        COMP         MASS      FRAC. VOL.     RHO(NVOID)=1.0   THETA= -1.00
      3     0.0000    3.7100+04    7.8000+00  0.0000     1.00000+00  1.9236-01    9.82948-01
      4     0.0000    0.0000       0.0000     0.0000     0.00000     0.0000       0.00000
```

```
      4    0.0000      0.0000      0.0000      0.0000      0.00000      0.0000      0.00000

J  MFLAG     U           V           P          SIE         COMP        TMASS        SZZ          SRR          SRZ          Z

3   108    0.0000     3.7100+04    0.0000      0.0000      0.00000     2.2077-01    0.0000      0.0000       0.0000     4.797-01
    NMAT     US          VS          RHO         SIE         COMP         MASS      FRAC. VOL.    RHO(NVOID)=1.0   THETA= -1.00
      3    0.0000     3.7100+04    7.8000+00   0.0000      1.00000+00   2.2077-01    9.82948-01
      4    0.0000     0.0000       0.0000      0.0000      0.00000      0.0000       0.00000
      4    0.0000     0.0000       0.0000      0.0000      0.00000      0.0000       0.00000

J  MFLAG     U           V           P          SIE         COMP        TMASS        SZZ          SRR          SRZ          Z

2   107    0.0000     3.7100+04    0.0000      0.0000      0.00000     2.5101-01    0.0000      0.0000       0.0000     2.836-01
    NMAT     US          VS          RHO         SIE         COMP         MASS      FRAC. VOL.    RHO(NVOID)=1.0   THETA= -1.00
      3    0.0000     3.7100+04    7.8000+00   0.0000      1.00000+00   2.5101-01    9.82948-01
      4    0.0000     0.0000       0.0000      0.0000      0.00000      0.0000       0.00000
      4    0.0000     0.0000       0.0000      0.0000      0.00000      0.0000       0.00000

J  MFLAG     U           V           P          SIE         COMP        TMASS        SZZ          SRR          SRZ          Z

1   106    0.0000     3.7100+04    0.0000      0.0000      0.00000     5.6264-04    0.0000      0.0000       0.0000     6.050-02
    NMAT     US          VS          RHO         SIE         COMP         MASS      FRAC. VOL.    RHO(NVOID)=1.0   THETA= -1.00
      3    0.0000     3.7100+04    7.8000+00   0.0000      1.00000+00   5.6264-04    8.12355-03
      4    0.0000     0.0000       0.0000      0.0000      0.00000      0.0000       0.00000
      4    0.0000     0.0000       0.0000      0.0000      0.00000      0.0000       0.00000

J  MFLAG     U           V           P          SIE         COMP        TMASS        SZZ          SRR          SRZ          Z
-----------------------------------------------------------------------------------------------------------------------------
I =  7     R(I) = 4.5619-01     DR(I) = 6.5170000-02     TAU(I) = 1.7345573-01     T = 0.0000000          CYCLE =     0
-----------------------------------------------------------------------------------------------------------------------------

J  MFLAG     U           V           P          SIE         COMP        TMASS        SZZ          SRR          SRZ          Z

27     3   0.0000     0.0000       0.0000      0.0000      1.00000+00   3.0730-02    0.0000      0.0000       0.0000     2.399+00
26     3   0.0000     0.0000       0.0000      0.0000      1.00000+00   3.0730-02    0.0000      0.0000       0.0000     2.336+00
25   137   0.0000     0.0000       0.0000      0.0000      0.00000      3.0730-02    0.0000      0.0000       0.0000     2.272+00
    NMAT     US          VS          RHO         SIE         COMP         MASS      FRAC. VOL.    RHO(NVOID)=1.0   THETA= -1.00
      3    0.0000     0.0000       0.0000      0.0000      0.00000      0.0000       0.00000
      4    0.0000     0.0000       0.0000      0.0000      0.00000      0.0000       0.00000
      4    0.0000     0.0000       2.7900+00   0.0000      1.00000+00   3.0730-02    9.99997-01

J  MFLAG     U           V           P          SIE         COMP        TMASS        SZZ          SRR          SRZ          Z

24     0   0.0000     0.0000       0.0000      0.0000      0.00000      0.0000       0.0000      0.0000       0.0000     2.209+00
23     0   0.0000     0.0000       0.0000      0.0000      0.00000      0.0000       0.0000      0.0000       0.0000     2.145+00
22     0   0.0000     0.0000       0.0000      0.0000      0.00000      0.0000       0.0000      0.0000       0.0000     2.082+00
21     0   0.0000     0.0000       0.0000      0.0000      0.00000      0.0000       0.0000      0.0000       0.0000     2.018+00
20     0   0.0000     0.0000       0.0000      0.0000      0.00000      0.0000       0.0000      0.0000       0.0000     1.953+00
19     0   0.0000     0.0000       0.0000      0.0000      0.00000      0.0000       0.0000      0.0000       0.0000     1.888+00
18     0   0.0000     0.0000       0.0000      0.0000      0.00000      0.0000       0.0000      0.0000       0.0000     1.823+00
17     0   0.0000     0.0000       0.0000      0.0000      0.00000      0.0000       0.0000      0.0000       0.0000     1.758+00
16     0   0.0000     0.0000       0.0000      0.0000      0.00000      0.0000       0.0000      0.0000       0.0000     1.693+00
15     0   0.0000     0.0000       0.0000      0.0000      0.00000      0.0000       0.0000      0.0000       0.0000     1.627+00
```

14	0	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.0000	0.0000	0.0000	[illegible]
13	0	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.0000	0.0000	0.0000	[illegible]
12	0	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.0000	0.0000	0.0000	1.432+00
11	0	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.0000	0.0000	0.0000	1.367+00
10	0	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.0000	0.0000	0.0000	1.302+00
9	0	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.0000	0.0000	0.0000	1.227+00
8	0	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.0000	0.0000	0.0000	1.141+00
7	0	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.0000	0.0000	0.0000	1.042+00
6	0	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.0000	0.0000	0.0000	9.294-01
5	0	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.0000	0.0000	0.0000	7.996-01
4	0	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.0000	0.0000	0.0000	6.507-01
3	0	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.0000	0.0000	0.0000	4.797-01
2	0	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.0000	0.0000	0.0000	2.836-01
1	0	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.0000	0.0000	0.0000	6.050-02

I = 8 R(I) = 5.2136-01 DR(I) = 6.5170000-02 TAU(I) = 2.0014123-01 T = 0.0000000 CYCLE = 0

J	MFLAG	U	V	P	SIE	COMP	TMASS	SZZ	SRR	SRZ	Z
27	3	0.0000	0.0000	0.0000	0.0000	1.00000+00	3.5458-02	0.0000	0.0000	0.0000	2.399+00
26	3	0.0000	0.0000	0.0000	0.0000	1.00000+00	3.5458-02	0.0000	0.0000	0.0000	2.336+00
25	138	0.0000	0.0000	0.0000	0.0000	0.00000	3.5458-02	0.0000	0.0000	0.0000	2.272+00

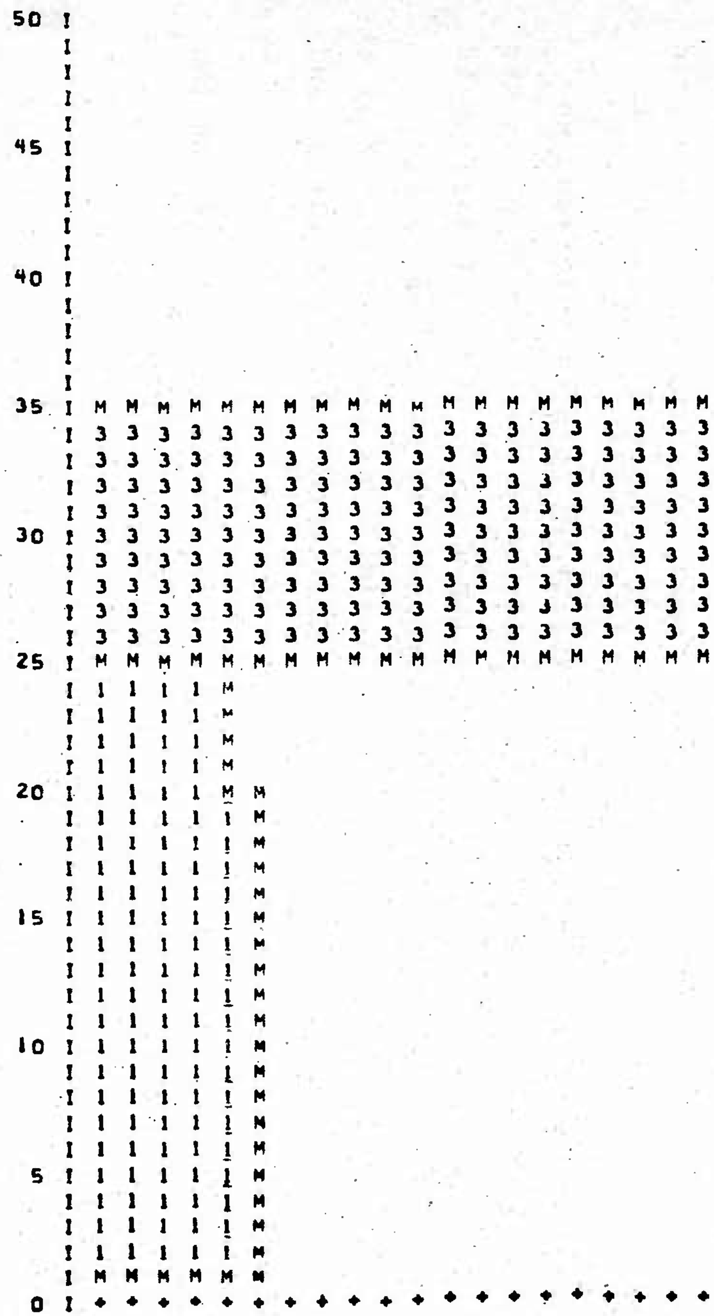
	NMAT	US	VS	RHO	SIE	COMP	MASS	FRAC. VOL.
	3	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.00000
	4	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.00000
	4	0.0000	0.0000	2.7900+00	0.0000	1.00000+00	3.5458-02	9.99997-01

RHO(NVOID)=1.0 THETA= -1.00

J	MFLAG	U	V	P	SIE	COMP	TMASS	SZZ	SRR	SRZ	Z
24	0	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.0000	0.0000	0.0000	2.209+00
23	0	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.0000	0.0000	0.0000	2.145+00
22	0	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.0000	0.0000	0.0000	2.082+00
21	0	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.0000	0.0000	0.0000	2.018+00
20	0	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.0000	0.0000	0.0000	1.953+00
19	0	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.0000	0.0000	0.0000	1.888+00
18	0	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.0000	0.0000	0.0000	1.823+00
17	0	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.0000	0.0000	0.0000	1.758+00
16	0	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.0000	0.0000	0.0000	1.693+00
15	0	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.0000	0.0000	0.0000	1.627+00
14	0	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.0000	0.0000	0.0000	1.562+00
13	0	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.0000	0.0000	0.0000	1.497+00
12	0	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.0000	0.0000	0.0000	1.432+00
11	0	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.0000	0.0000	0.0000	1.367+00
10	0	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.0000	0.0000	0.0000	1.302+00
9	0	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.0000	0.0000	0.0000	1.227+00
8	0	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.0000	0.0000	0.0000	1.141+00
7	0	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.0000	0.0000	0.0000	1.042+00
6	0	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.0000	0.0000	0.0000	9.294-01
5	0	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.0000	0.0000	0.0000	7.996-01
4	0	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.0000	0.0000	0.0000	6.507-01
3	0	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.0000	0.0000	0.0000	4.797-01
2	0	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.0000	0.0000	0.0000	2.836-01
1	0	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.0000	0.0000	0.0000	6.050-02

```
SPHASE   ETH=   5.09199226+09   ESUM=   5.09199130+09   EMIX=   5.09199130+09   RELERR=   -1.88581315-07
HPHASE   ETH=   5.09199226+09   ESUM=   5.09199130+09   EMIX=   5.09199130+09   RELERR=   -1.88581315-07
```

DISPLAY OF MIXED AND PURE CELLS   M = MIXED CELL   NUMERAL N = PURE CELL OF PACKAGE N MATERIAL



11.3 IMPACT INTO A THICK TARGET

This calculation illustrates the impact of a heavy metal projectile into a thick metal target. This is a situation in which plugging failure is not expected, therefore the plugging option is not used and, by default, PLGOPT = 0. In this calculation there are two material packages and a void (NMAT = 2): package one is the tungsten projectile and its initial axial velocity is 5.5×10^4 cm/sec; package two is the steel target; and package three is the void. (The void package number is always NMAT + 1.)

Figure 11.6 shows the initial configuration of the problem, and Figure 11.7 shows the initial zoning of the grid relative to the dimensions of the projectile and target. The finest zoning was chosen to be in the region of the impact where the greatest material deformation is expected to occur. The value of DY(1) was chosen so that the initial projectile-target interface would be coincident with a grid line, a desirable procedure but not a requirement.

Sliplines are not necessary in this calculation, so NOSLIP is set to 1, and the cards defining the slipline endpoints are omitted from the input deck. The automatic void closing routine is used, however. It is activated by setting NVRTEX = 108 which indentifies the void tracer at the vertex point, which is the intercept between the target and projectile edge.

The input cards for this calculation are listed on the following pages along with the cycle 0 output.

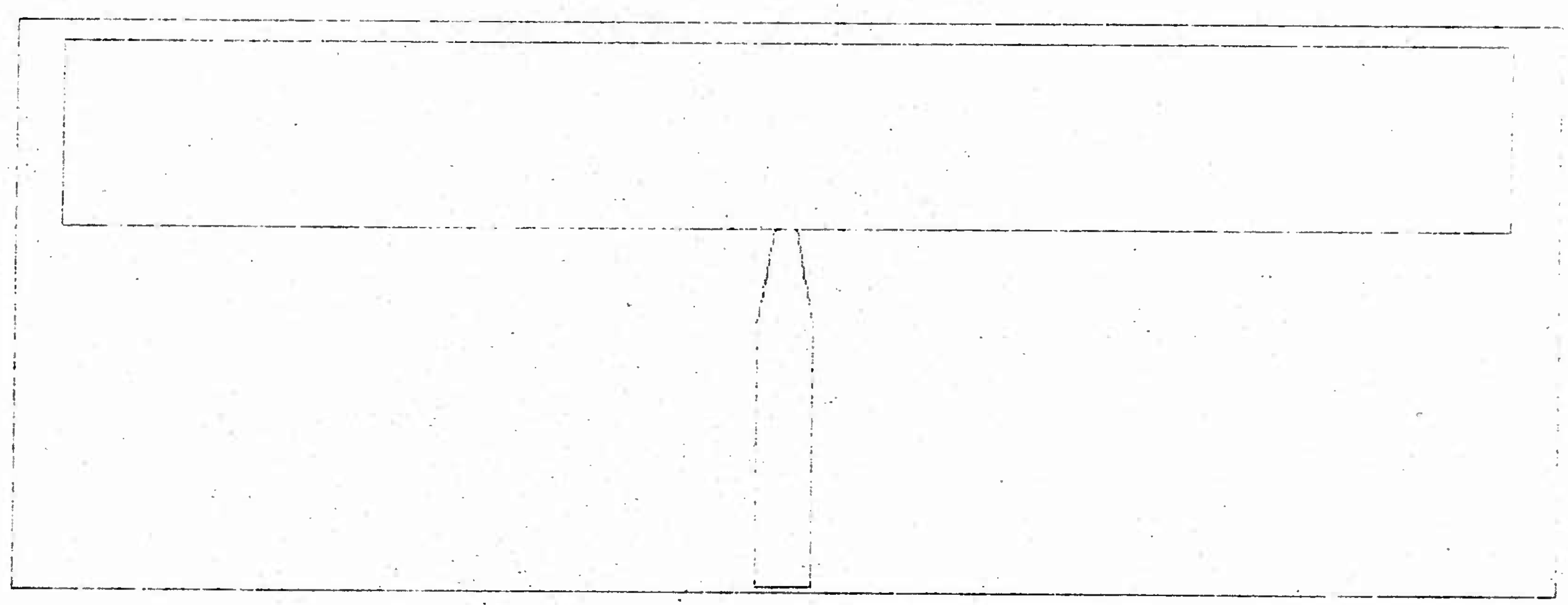


Figure 11.6--Initial configuration of the impact into a thick target calculation.

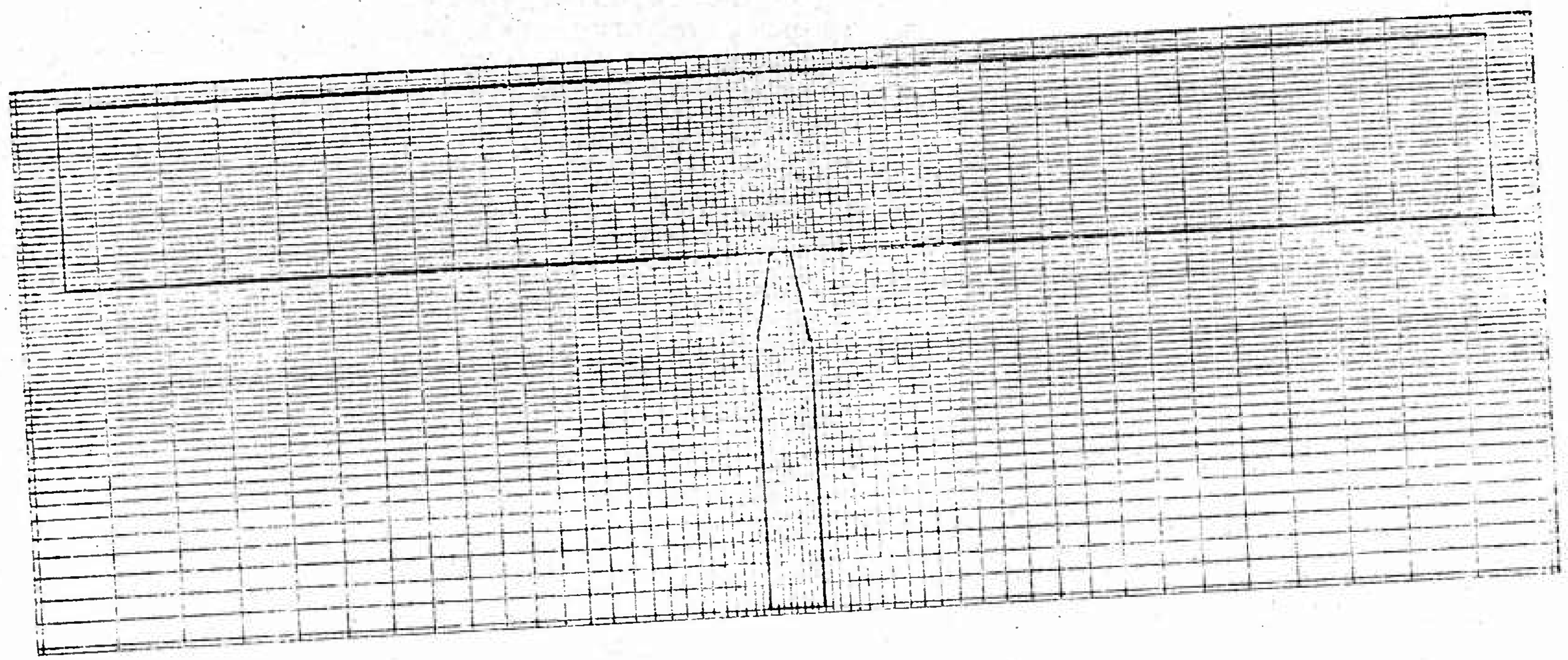


Figure 11.7--Initial zoning of the grid relative to the dimensions of the projectile and target in the impact into a thick target calculation.

11.3.1 Input

```
 2-6   8-16                                                                          Column Indicator
1234567890123456789012345678901234567890123456789012345678901234567890123456789012345678890

           IMPACT INTO A THICK TARGET                                                Heading Card
1   15115.5                                                                          PK(1)
      115.5                                                                          PROB
2     514.                                                                           NFRELP
2     611.                                                                           NDUMP7
    271-1.                                                                           CVIS
2   33130.                                                                           IMAX
2   35162.                                                                           JMAX
2   4211.                                                                            MAPS
    4512.5     -36                                                                   PRDELT
2   4717.                                                                            I1
2   48137.                                                                           I2
2   6812.                                                                            NMAT
2   7213.                                                                            NTRACR
2   731400.                                                                          NMXCLS
2   781350.                                                                          NTPMX
2   1091108.                                                                         NVRTEX
2   11511.                                                                           NOSLIP
2   118110.                                                                          NADD
2   11911.                                                                           MINX
2   120120.                                                                          MAXX
2   121115.                                                                          MINY
2   122145.                                                                          MAXY
1    5012.5    -36                                                                   TSTOP
```

Column Indicator

1-10		11-20		21-30	31-40	41-50	51-60	
1234567890		1234567890		1234567890	1234567890	1234567890	1234567890	12345678901234567890
4	1	1	1	.184	.20	.22	.24	DX
1	1	1	1	.27	.29	.32	.35	
1	1	1	1	.39	.43	.47	.52	
1	1	1	1	.57	.63	.69	.76	
1	1	1	1	.84	.92	1.01	1.11	
1	1	1	1	1.22	1.35	1.49	1.63	
1	1	1	999	1.80	1.98	.20		
1	1	1	1	.20	.64	.64	.63	DY
1	1	1	1	.57	.52	.47	.43	
1	1	1	1	.39	.35	.32	.29	
1	1	1	47	.27	.24	.22	.20	
999								
								MFLAG(2)
0								
1		19.17		0.	3.	5.5	+04	MAT, ρ, E_I, U, V
3		7.8		0.	0.	0.		
1.01		+100.		0.	2.28	+097.75	+11.9753	Y_o, Y_1, Y_2, E_m, G, AMDM
6.0		+090.		0.	1.3	+108.3	+11.97	

```
                                                                    Column Indicator
 1-5 |6-10 |11-15|16-20|   21-30   |   31-40   |
12345|67890|12345|67890|1234567890|1234567890|1234567890123456789012345678901234567890

    1    1    3
0.        .2001     .7365     .2001
    2    1   11
.7365     .45       .7365     6.0
    2    1   10
.7365     6.07      .7365     7.37                        Material Tracers
    3    1   15                                           for Package 1
.7365     7.44      .2885     9.98                         (Projectile)
   -1    1    4
.2524     9.98      0.        9.98

    1    2    4
0.        9.98      .2524     9.98
    1    2   23
.2885     9.98      3.0       9.98
    1    2   25                                           Material Tracers
3.33      9.98      19.4      9.98                        for Package 2
    2    2   15                                            (Target)
19.4      10.15     19.4      14.89
    1    2   25
19.4      15.06     3.33      15.06
   -1    2   20
3.0       15.06     0.        15.06

    1    3   20
0.        15.06     3.0       15.06
    1    3   25
3.33      15.06     19.4      15.06
    2    3   15
19.4      14.89     19.4      10.15
    1    3   25
19.4      9.98      3.33      9.98
    1    3   23                                           Material Tracers
3.0       9.98      .2885     9.98                        for Package 3
    3    3   15                                            (Void)
.2885     9.98      .7365     7.44
    2    3   10
.7365     7.37      .7365     6.07
    2    3   11
.7365     6.0       .7365     .45
   -1    3    3
.7365     .2001     0.        .2001

  100                                                     End of Material Tracer Data
```

```
                                                                              Column Indicator
12345678901234567890123456789012345678901234567890123456789012345678901234567890

0                                                         Detonation Point (dummy card)

1   15010.                                                End of Input
```

11.3.2 Cycle 0 Output

```
          IMPACT INTO A THICK TARGET
   INPUT CARDS


1     151   1    5.500000+00
   INPUT CARDS


0       1   1    5.500000+00
2       5   1    4.000000+00
2       6   1    1.000000+00
0      27   1   -1.000000+00
2      33   1    3.000000+01
2      36   1    6.200000+01
2      42   1    1.000000+00
0      45   1    2.500000-06
2      47   1    7.000000+00
2      48   1    3.700000+01
2      68   1    2.000000+00
2      72   1    3.000000+00
2      73   1    4.000000+02
2      78   1    3.500000+02
2     109   1    1.080000+02
2     115   1    1.000000+00
2     118   1    1.000000+01
2     119   1    1.000000+00
2     120   1    2.000000+01
2     121   1    1.500000+01
2     122   1    4.500000+01
1      50   1    2.500000-06
 TYPE=    1       PACKAGE=   1      NUMBER OF POINTS=    3
 X1=     .0000000           Y1=     .2001000+00      X2=     .7365000+00      Y2=     .2001000+00
 TYPE=    2       PACKAGE=   1      NUMBER OF POINTS=   11
 X1=     .7365000+00        Y1=     .4500000+00      X2=     .7365000+00      Y2=     .6000000+01
 TYPE=    2       PACKAGE=   1      NUMBER OF POINTS=   10
 X1=     .7365000+00        Y1=     .6070000+01      X2=     .7365000+00      Y2=     .7370000+01
 TYPE=    3       PACKAGE=   1      NUMBER OF POINTS=   15
 X1=     .7365000+00        Y1=     .7440000+01      X2=     .2885000+00      Y2=     .9980000+01
 TYPE=   -1       PACKAGE=   1      NUMBER OF POINTS=    4
 X1=     .2524000+00        Y1=     .9980000+01      X2=     .0000000         Y2=     .9980000+01
 TYPE=    1       PACKAGE=   2      NUMBER OF POINTS=    4
 X1=     .0000000           Y1=     .9980000+01      X2=     .2524000+00      Y2=     .9980000+01
 TYPE=    1       PACKAGE=   2      NUMBER OF POINTS=   23
 X1=     .2885000+00        Y1=     .9980000+01      X2=     .3000000+01      Y2=     .9980000+01
```

```
TYPE=   1     PACKAGE=  2     NUMBER OF POINTS=   25
X1=   .3330000+01    Y1=   .9980000+01    X2=   .1940000+02    Y2=   .9980000+01
TYPE=   2     PACKAGE=  2     NUMBER OF POINTS=   15
X1=   .1940000+02    Y1=   .1015000+02    X2=   .1940000+02    Y2=   .1489000+02
TYPE=   1     PACKAGE=  2     NUMBER OF POINTS=   25
X1=   .1940000+02    Y1=   .1506000+02    X2=   .3330000+01    Y2=   .1506000+02
TYPE=  -1     PACKAGE=  2     NUMBER OF POINTS=   20
X1=   .3000000+01    Y1=   .1506000+02    X2=   .0000000       Y2=   .1506000+02
TYPE=   1     PACKAGE=  3     NUMBER OF POINTS=   20
X1=   .0000000       Y1=   .1506000+02    X2=   .3000000+01    Y2=   .1506000+02
TYPE=   1     PACKAGE=  3     NUMBER OF POINTS=   25
X1=   .3330000+01    Y1=   .1506000+02    X2=   .1940000+02    Y2=   .1506000+02
TYPE=   2     PACKAGE=  3     NUMBER OF POINTS=   15
X1=   .1940000+02    Y1=   .1489000+02    X2=   .1940000+02    Y2=   .1015000+02
TYPE=   1     PACKAGE=  3     NUMBER OF POINTS=   25
X1=   .1940000+02    Y1=   .9980000+01    X2=   .3330000+01    Y2=   .9980000+01
TYPE=   1     PACKAGE=  3     NUMBER OF POINTS=   23
X1=   .3000000+01    Y1=   .9980000+01    X2=   .2885000+00    Y2=   .9980000+01
TYPE=   3     PACKAGE=  3     NUMBER OF POINTS=   15
X1=   .2885000+00    Y1=   .9980000+01    X2=   .7365000+00    Y2=   .7490000+01
TYPE=   2     PACKAGE=  3     NUMBER OF POINTS=   10
X1=   .7365000+00    Y1=   .7370000+01    X2=   .7365000+00    Y2=   .6070000+01
TYPE=   2     PACKAGE=  3     NUMBER OF POINTS=   11
X1=   .7365000+00    Y1=   .6000000+01    X2=   .7365000+00    Y2=   .4500000+00
TYPE=  -1     PACKAGE=  3     NUMBER OF POINTS=    3
X1=   .7365000+00    Y1=   .2001000+00    X2=   .0000000       Y2=   .2001000+00
TYPE= 100     PACKAGE=  0     NUMBER OF POINTS=    0

 INPUT CARDS


  150   1    0.000000


ICSTOP      IDLT      IDRT     IEXTX       IGM      IMAX     INTER    IPCYCL    IPLGBT    IPLGRT
     0         0         0         0         0        30         0         0         0         0

IPLGTP       IPR        I1        I2      JDBT      JDTP     JEXTY      JMAX    KUNITR    KUNITW
     0        35         7        37         0         0         0        62         7         7

 LVISC      MAPS      MAXX      MAXY      MINX      MINY      NADD    NDUMP7    NFRELP    NLINER
     0         1        20        45         1        15        10         1         4         0

  NMAT    NMXCLS    NODUMP    NOSLIP      NSLD      NTCC     NTPMX    NTRACR    NUMSCA    NUMREZ
     2       480         0         1         0         0       350         3         0         0

NVRTEX
   108

       BBAR      CRATIO        CVIS       CYCMX      CYCPH3        DMIN       DTMIN        EMIN       FINAL
 5.0000-01  1.0000+04  -1.0000+00  2.0000+00  1.0000+00  1.0000-03  1.0000-11  1.0000+07  4.0000-01
```

GAMMA	PLGOPT	PLWMIN	PMIN	PRCNT	PRDELT	PRFACT	PRLIM	PROB
0.0000	0.0000	0.0000	5.0000+06	1.0000-03	2.5000-06	0.0000	0.0000	5.5000+00

REZ	ROEPS	SIEMIN	STAB	TSTOP
0.0000	1.0000-05	1.0000+05	1.0000-03	2.5000-06

INITIAL CONDITIONS

PACKAGE NUMBER	NORMAL DENSITY (RHOZ)	DENSITY (RHOIN)	S.I.E.	U	V	MATERIAL
1	19.170	19.170	0.0000	0.0000	5.5000+04	TUNGSTEN
2	7.800	7.800	0.0000	0.0000	0.0000	IRON

STRENGTH CONSTANTS

PACKAGE NUMBER	CZERO	STK1	STK2	STEZ	RMU	AMDM
1	1.010+10	0.000	0.000	8.280+09	7.750+11	9.753-01
2	6.000+09	0.000	0.000	1.300+10	8.000+11	9.700-01

I	DR	I	DR	I	DR	I	DR	I	DR	I	DR	I	DR
1	1.840-01	2	1.840-01	3	1.840-01	4	1.840-01	5	2.000-01	6	2.200-01	7	2.400-01
8	2.700-01	9	2.900-01	10	3.200-01	11	3.500-01	12	3.900-01	13	4.300-01	14	4.700-01
15	5.200-01	16	5.700-01	17	6.300-01	18	6.900-01	19	7.600-01	20	8.400-01	21	9.200-01
22	1.010+00	23	1.110+00	24	1.220+00	25	1.350+00	26	1.490+00	27	1.630+00	28	1.800+00
29	1.980+00	30	2.000-01										

I	R	I	R	I	R	I	R	I	R	I	R	I	R
1	1.840-01	2	3.680-01	3	5.520-01	4	7.360-01	5	9.360-01	6	1.156+00	7	1.396+00
8	1.666+00	9	1.956+00	10	2.276+00	11	2.626+00	12	3.016+00	13	3.446+00	14	3.916+00
15	4.436+00	16	5.006+00	17	5.636+00	18	6.326+00	19	7.086+00	20	7.926+00	21	8.846+00
22	9.856+00	23	1.097+01	24	1.219+01	25	1.354+01	26	1.503+01	27	1.666+01	28	1.846+01
29	2.044+01	30	2.064+01										

J	DZ	J	DZ	J	DZ	J	DZ	J	DZ	J	DZ	J	DZ
1	2.000-01	2	6.400-01	3	6.400-01	4	6.300-01	5	5.700-01	6	5.200-01	7	4.700-01
8	4.300-01	9	3.900-01	10	3.500-01	11	3.200-01	12	2.900-01	13	2.700-01	14	2.400-01
15	2.200-01	16	2.000-01	17	2.000-01	18	2.000-01	19	2.000-01	20	2.000-01	21	2.000-01
22	2.000-01	23	2.000-01	24	2.000-01	25	2.000-01	26	2.000-01	27	2.000-01	28	2.000-01
29	2.000-01	30	2.000-01	31	2.000-01	32	2.000-01	33	2.000-01	34	2.000-01	35	2.000-01
36	2.000-01	37	2.000-01	38	2.000-01	39	2.000-01	40	2.000-01	41	2.000-01	42	2.000-01
43	2.000-01	44	2.000-01	45	2.000-01	46	2.000-01	47	2.000-01	48	2.000-01	49	2.000-01
50	2.000-01	51	2.000-01	52	2.000-01	53	2.000-01	54	2.000-01	55	2.000-01	56	2.000-01
57	2.000-01	58	2.000-01	59	2.000-01	60	2.000-01	61	2.000-01	62	2.000-01		

J	Z	J	Z	J	Z	J	Z	J	Z	J	Z	J	Z
1	2.000-01	2	8.400-01	3	1.480+00	4	2.110+00	5	2.680+00	6	3.200+00	7	3.670+00
8	4.100+00	9	4.490+00	10	4.840+00	11	5.160+00	12	5.450+00	13	5.720+00	14	5.960+00
15	6.180+00	16	6.380+00	17	6.580+00	18	6.780+00	19	6.980+00	20	7.180+00	21	7.380+00
22	7.580+00	23	7.780+00	24	7.980+00	25	8.180+00	26	8.380+00	27	8.580+00	28	8.780+00
29	8.980+00	30	9.180+00	31	9.380+00	32	9.580+00	33	9.780+00	34	9.980+00	35	1.018+01
36	1.038+01	37	1.058+01	38	1.078+01	39	1.098+01	40	1.118+01	41	1.138+01	42	1.158+01

```
43   1.178+01    44   1.198+01    45   1.218+01    46   1.238+01    47   1.258+01    48   1.278+01    49   1.298+01
50   1.318+01    51   1.338+01    52   1.358+01    53   1.378+01    54   1.398+01    55   1.418+01    56   1.438+01
57   1.458+01    58   1.478+01    59   1.498+01    60   1.518+01    61   1.538+01    62   1.558+01
CYCLE    0

CDT  4  21   T= 0.0000000     DT= 8.0701759-10  MAXCUV= 4.5600000+05  MAXUV= 5.5000000+04  UMIN= 4.5599999+00  PMIN= 5.0000000+06
```

PROBLEM	TIME	CYCLE	TOT.EN.THEOR.	MAX.REL.ERROR-CYCLE		IE SET TO ZERO-PH2	ELASTIC PLASTIC WORK
5.5000	0.0000000	0	4.2236133+11	-4.8489887-08	0	0.0000000	0.0000000

PACKAGE NO.	IE	KE	TOT.EN. (SUM)	MASS	MV	MV(POSITIVE)	MU	PLASTIC-WORK
1	0.0000000	4.2236131+11	4.2236131+11	2.7924706+02	1.5358593+07	1.5358593+07	0.0000000	0.0000000
2	0.0000000	0.0000000	0.0000000	4.6850132+04	0.0000000	0.0000000	0.0000000	0.0000000
TOTALS	0.0000000	4.2236131+11	4.2236131+11	4.7129379+04	1.5358593+07	1.5358593+07	0.0000000	0.0000000

	IE OUT	KE OUT
1	0.0000000	0.0000000
2	0.0000000	0.0000000

BOUNDARY	BOTTOM	RIGHT	TOP	$EVAPORATED$
MASS OUT	0.0000000	0.0000000	0.0000000	0.0000000
ENERGY OUT	0.0000000	0.0000000	0.0000000	0.0000000
MU OUT	0.0000000	0.0000000	0.0000000	0.0000000
MV OUT	0.0000000	0.0000000	0.0000000	0.0000000
WORK DONE	0.0000000	0.0000000	0.0000000	

DEFINITION OF SLIDE ENDPOINTS

PKG. NO.	MASTER	SLAVE	NBGM	NBGS	NENDM	NENDS
1	0	0	0	0	0	0
2	0	0	0	0	0	0

CELL-COORDINATES OF TRACERS FOR EACH MATERIAL PACKAGE

PACKAGE 1

N	X	Y	N	X	Y	N	X	Y	N	X	Y	N	X	Y
1	.00	1.00	2	2.00	1.00	3	4.00	1.00	4	4.00	1.39	5	4.00	2.26
6	4.00	3.13	7	4.00	4.01	8	4.00	4.98	9	4.00	6.05	10	4.00	7.26
11	4.00	8.60	12	4.00	10.16	13	4.00	11.98	14	4.00	14.18	15	4.00	14.58
16	4.00	15.17	17	4.00	15.89	18	4.00	16.62	19	4.00	17.34	20	4.00	18.06
21	4.00	18.78	22	4.00	19.61	23	4.00	20.23	24	4.00	20.95	25	4.00	21.30
26	3.83	22.21	27	3.65	23.11	28	3.48	24.02	29	3.31	24.93	30	3.13	25.84
31	2.96	26.74	32	2.79	27.65	33	2.61	28.56	34	2.44	29.46	35	2.26	30.37
36	2.09	31.28	37	1.92	32.19	38	1.74	33.09	39	1.57	34.00	40	1.37	34.00
41	.91	34.00	42	.46	34.00	43	.00	34.00	44	-1000.00	.00			

PACKAGE 2

N	X	Y	N	X	Y	N	X	Y	N	X	Y	N	X	Y
1	.00	34.00	2	.46	34.00	3	.91	34.00	4	1.37	34.00	5	1.57	34.00
6	2.24	34.00	7	2.91	34.00	8	3.58	34.00	9	4.23	34.00	10	4.84	34.00

11	5.42	34.00	12	5.98	34.00	13	6.49	34.00	14	7.01	34.00	15	7.46	34.00
16	7.92	34.00	17	8.35	34.00	18	8.77	34.00	19	9.18	34.00	20	9.57	34.00
21	9.95	34.00	22	10.31	34.00	23	10.66	34.00	24	11.01	34.00	25	11.33	34.00
26	11.64	34.00	27	11.96	34.00	28	12.73	34.00	29	14.16	34.00	30	15.41	34.00
31	16.53	34.00	32	17.54	34.00	33	18.46	34.00	34	19.31	34.00	35	20.10	34.00
36	20.83	34.00	37	21.51	34.00	38	22.15	34.00	39	22.76	34.00	40	23.33	34.00
41	23.88	34.00	42	24.38	34.00	43	24.88	34.00	44	25.34	34.00	45	25.79	34.00
46	26.22	34.00	47	26.63	34.00	48	27.04	34.00	49	27.41	34.00	50	27.78	34.00
51	28.14	34.00	52	28.48	34.00	53	28.48	34.85	54	28.48	36.54	55	28.48	38.24
56	28.48	39.93	57	28.48	41.62	58	28.48	43.31	59	28.48	45.01	60	28.48	46.70
61	28.48	48.39	62	28.48	50.09	63	28.48	51.78	64	28.48	53.47	65	28.48	55.16
66	28.48	56.86	67	28.48	58.55	68	28.48	59.40	69	28.14	59.40	70	27.78	59.40
71	27.41	59.40	72	27.04	59.40	73	26.63	59.40	74	26.22	59.40	75	25.79	59.40
76	25.34	59.40	77	24.88	59.40	78	24.38	59.40	79	23.88	59.40	80	23.33	59.40
81	22.76	59.40	82	22.15	59.40	83	21.51	59.40	84	20.83	59.40	85	20.10	59.40
86	19.31	59.40	87	18.46	59.40	88	17.54	59.40	89	16.53	59.40	90	15.41	59.40
91	14.16	59.40	92	12.73	59.40	93	11.96	59.40	94	11.55	59.40	95	11.15	59.40
96	10.72	59.40	97	10.26	59.40	98	9.80	59.40	99	9.30	59.40	100	8.79	59.40
101	8.24	59.40	102	7.68	59.40	103	7.09	59.40	104	6.45	59.40	105	5.77	59.40
106	5.05	59.40	107	4.27	59.40	108	3.43	59.40	109	2.57	59.40	110	1.72	59.40
111	.86	59.40	112	.00	59.40	113	-1000.00	.00						

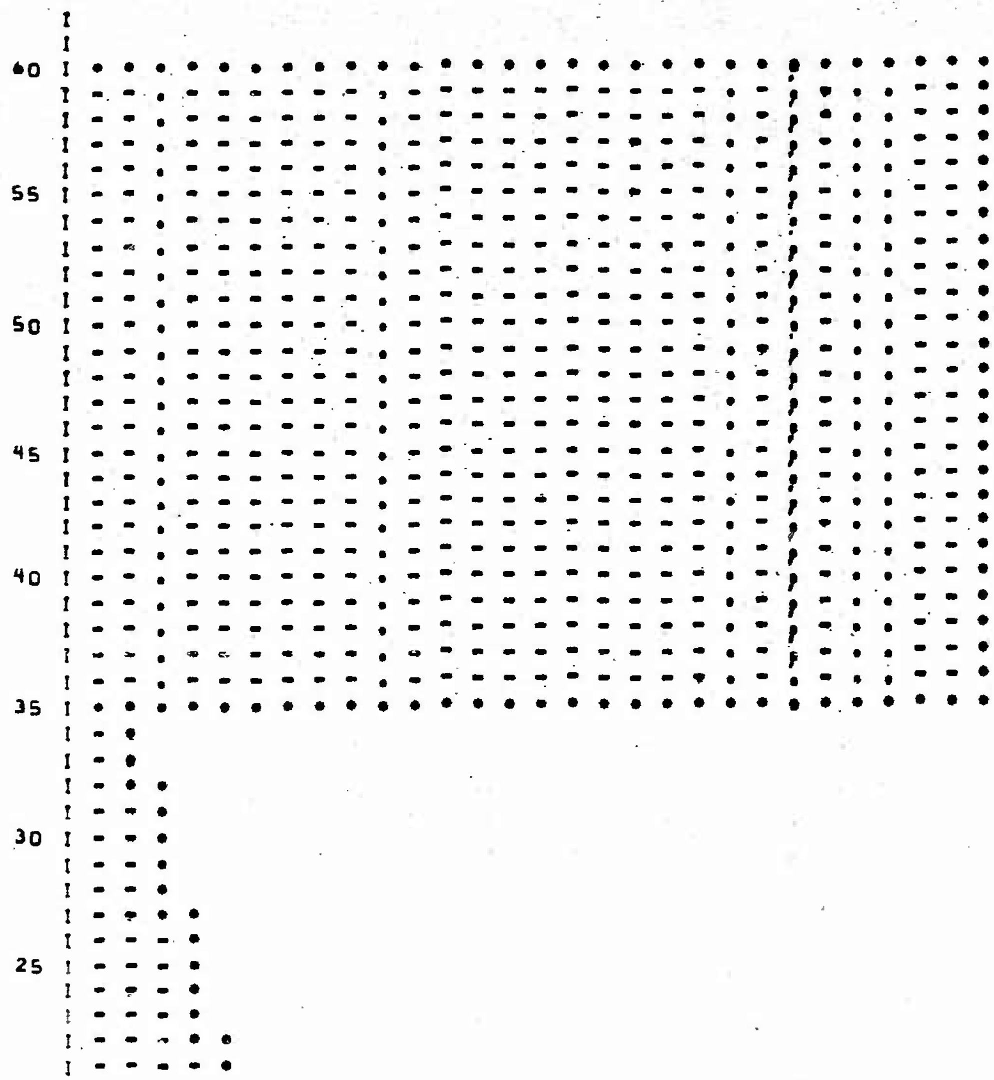
FREE SURFACE TRACERS NVRTEX= 108

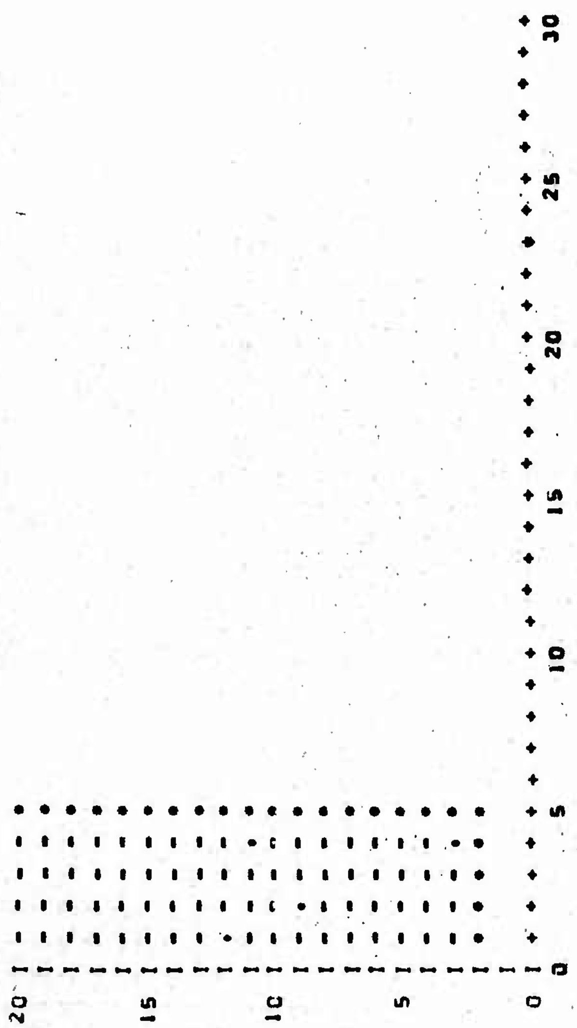
N	X	Y	N	X	Y	N	X	Y	N	X	Y	N	X	Y
1	.00	59.40	2	.86	59.40	3	1.72	59.40	4	2.57	59.40	5	3.43	59.40
6	4.27	59.40	7	5.05	59.40	8	5.77	59.40	9	6.45	59.40	10	7.09	59.40
11	7.68	59.40	12	8.24	59.40	13	8.79	59.40	14	9.30	59.40	15	9.80	59.40
16	10.26	59.40	17	10.72	59.40	18	11.15	59.40	19	11.55	59.40	20	11.96	59.40
21	12.73	59.40	22	14.16	59.40	23	15.41	59.40	24	16.53	59.40	25	17.54	59.40
26	18.46	59.40	27	19.31	59.40	28	20.10	59.40	29	20.83	59.40	30	21.51	59.40
31	22.15	59.40	32	22.76	59.40	33	23.33	59.40	34	23.88	59.40	35	24.38	59.40
36	24.88	59.40	37	25.34	59.40	38	25.79	59.40	39	26.22	59.40	40	26.63	59.40
41	27.04	59.40	42	27.41	59.40	43	27.78	59.40	44	28.14	59.40	45	28.48	59.40
46	28.48	58.55	47	28.48	56.86	48	28.48	55.16	49	28.48	53.47	50	28.48	51.78
51	28.48	50.09	52	28.48	48.39	53	28.48	46.70	54	28.48	45.01	55	28.48	43.31
56	28.48	41.62	57	28.48	39.93	58	28.48	38.24	59	28.48	36.54	60	28.48	34.85
61	28.48	34.00	62	28.14	34.00	63	27.78	34.00	64	27.41	34.00	65	27.04	34.00
66	26.63	34.00	67	26.22	34.00	68	25.79	34.00	69	25.34	34.00	70	24.88	34.00
71	24.38	34.00	72	23.88	34.00	73	23.33	34.00	74	22.76	34.00	75	22.15	34.00
76	21.51	34.00	77	20.83	34.00	78	20.10	34.00	79	19.31	34.00	80	18.46	34.00
81	17.54	34.00	82	16.53	34.00	83	15.41	34.00	84	14.16	34.00	85	12.73	34.00
86	11.96	34.00	87	11.64	34.00	88	11.33	34.00	89	11.01	34.00	90	10.66	34.00
91	10.31	34.00	92	9.95	34.00	93	9.57	34.00	94	9.18	34.00	95	8.77	34.00
96	8.35	34.00	97	7.92	34.00	98	7.46	34.00	99	7.01	34.00	100	6.49	34.00
101	5.98	34.00	102	5.42	34.00	103	4.64	34.00	104	4.23	34.00	105	3.58	34.00
106	2.91	34.00	107	2.24	34.00	108	1.57	34.00	109	1.74	33.09	110	1.92	32.19
111	2.09	31.28	112	2.26	30.37	113	2.44	29.46	114	2.61	28.56	115	2.79	27.65
116	2.96	26.74	117	3.13	25.84	118	3.31	24.93	119	3.48	24.02	120	3.65	23.11
121	3.83	22.21	122	4.00	21.30	123	4.00	20.95	124	4.00	20.23	125	4.00	19.51
126	4.00	18.78	127	4.00	18.06	128	4.00	17.34	129	4.00	16.62	130	4.00	15.89
131	4.00	15.17	132	4.00	14.50	133	4.00	14.18	134	4.00	11.98	135	4.00	10.16
136	4.00	8.60	137	4.00	7.26	138	4.00	6.05	139	4.00	4.98	140	4.00	4.01
141	4.00	3.13	142	4.00	2.26	143	4.00	1.39	144	4.00	1.00	145	2.00	1.00

146	.00	1.00	147-1000.00	.00

COMPRESSION CYCLE= .0 TIME= 0.00000 SECONDS

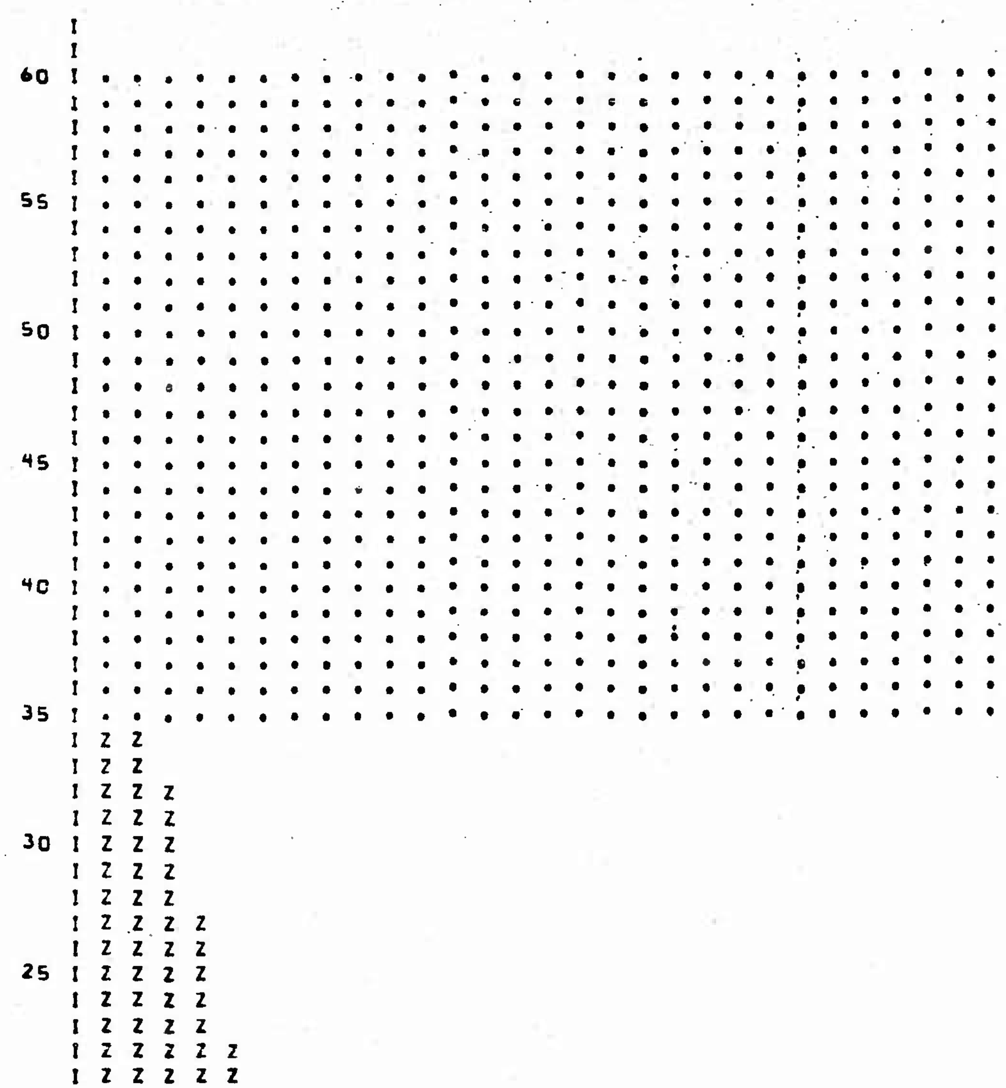
SYMBOL	.	-	A	B	C	D	E	F	G	H
MAXIMUM VALUE	1.000	1.001	1.002	1.003	1.004	1.005	1.006	1.007	1.008	1.009
SYMBOL	I	J	K	L	M	N	O	P	Q	R
MAXIMUM VALUE	1.010	1.011	1.012	1.013	1.014	1.015	1.016	1.017	1.018	1.019
SYMBOL	S	T	U	V	W	X	Y	Z		
MAXIMUM VALUE	1.020	1.021	1.022	1.023	1.024	1.025	1.026	1.027		




0
5
10
15
20
25
30
0
5
10
15
20

AXIAL VELOCITY CYCLE= .0 TIME= 0.00000 SECONDS

SYMBOL	.	-	A	B	C	D	E	F	G	H
MAXIMUM VALUE	0.00	2.12+02	2.12+03	4.23+03	6.35+03	8.46+03	1.06+04	1.27+04	1.48+04	1.69+04
SYMBOL	I	J	K	L	M	N	O	P	Q	R
MAXIMUM VALUE	1.90+04	2.12+04	2.33+04	2.54+04	2.75+04	2.96+04	3.17+04	3.38+04	3.60+04	3.81+04
SYMBOL	S	T	U	V	W	X	Y	Z		
MAXIMUM VALUE	4.02+04	4.23+04	4.44+04	4.65+04	4.87+04	5.08+04	5.29+04	5.50+04		



```
20 I Z Z Z Z Z
   I Z Z Z Z Z
   I Z Z Z Z Z
   I Z Z Z Z Z
   I Z Z Z Z Z
15 I Z Z Z Z Z
   I Z Z Z Z Z
   I Z Z Z Z Z
   I Z Z Z Z Z
   I Z Z Z Z Z
10 I Z Z Z Z Z
   I Z Z Z Z Z
   I Z Z Z Z Z
   I Z Z Z Z Z
   I Z Z Z Z Z
 5 I Z Z Z Z Z
   I Z Z Z Z Z
   I Z Z Z Z Z
   I Z Z Z Z Z
   I
 0 I + + + + + + + + + + + + + + + + + + + + + + + + + + + + + + +
   0         5        10        15        20        25        30
```

I = 1 R(I) = 1.8400-01 DR(I) = 1.8400000-01 TAU(I) = 1.0636176-01 T = 0.0000000 CYCLE = 0

J	MFLAG	U	V	P	SIE	COMP	TMASS	SZZ	SRR	SRZ	Z
37	2	0.0000	0.0000	0.0000	0.0000	1.00000+00	1.4592-01	0.0000	0.0000	0.0000	1.058+01
36	2	0.0000	0.0000	0.0000	0.0000	1.00000+00	1.4592-01	0.0000	0.0000	0.0000	1.038+01
35	142	0.0000	0.0000	0.0000	0.0000	0.00000	1.4592-01	0.0000	0.0000	0.0000	1.018+01

RHO(NVOID)= .0 THETA= -1.00

	NMAT	US	VS	RHO	SIE	COMP	MASS	FRAC. VOL.
	1	0.0000	0.0000	1.9170+01	0.0000	1.00000+00	0.0000	0.00000
	3	0.0000	0.0000	7.8000+00	0.0000	9.99995-01	1.4592-01	1.00000+00

J	MFLAG	U	V	P	SIE	COMP	TMASS	SZZ	SRR	SRZ	Z
34	1	0.0000	5.5000+04	0.0000	0.0000	1.00000+00	4.0779-01	0.0000	0.0000	0.0000	9.980+00
33	1	0.0000	5.5000+04	0.0000	0.0000	1.00000+00	4.0779-01	0.0000	0.0000	0.0000	9.780+00
32	1	0.0000	5.5000+04	0.0000	0.0000	1.00000+00	4.0779-01	0.0000	0.0000	0.0000	9.580+00
31	1	0.0000	5.5000+04	0.0000	0.0000	1.00000+00	4.0779-01	0.0000	0.0000	0.0000	9.380+00
30	1	0.0000	5.5000+04	0.0000	0.0000	1.00000+00	4.0779-01	0.0000	0.0000	0.0000	9.180+00
29	1	0.0000	5.5000+04	0.0000	0.0000	1.00000+00	4.0779-01	0.0000	0.0000	0.0000	8.980+00
28	1	0.0000	5.5000+04	0.0000	0.0000	1.00000+00	4.0779-01	0.0000	0.0000	0.0000	8.780+00
27	1	0.0000	5.5000+04	0.0000	0.0000	1.00000+00	4.0779-01	0.0000	0.0000	0.0000	8.580+00
26	1	0.0000	5.5000+04	0.0000	0.0000	1.00000+00	4.0779-01	0.0000	0.0000	0.0000	8.380+00
25	1	0.0000	5.5000+04	0.0000	0.0000	1.00000+00	4.0779-01	0.0000	0.0000	0.0000	8.180+00
24	1	0.0000	5.5000+04	0.0000	0.0000	1.00000+00	4.0779-01	0.0000	0.0000	0.0000	7.980+00
23	1	0.0000	5.5000+04	0.0000	0.0000	1.00000+00	4.0779-01	0.0000	0.0000	0.0000	7.780+00
22	1	0.0000	5.5000+04	0.0000	0.0000	1.00000+00	4.0779-01	0.0000	0.0000	0.0000	7.580+00
21	1	0.0000	5.5000+04	0.0000	0.0000	1.00000+00	4.0779-01	0.0000	0.0000	0.0000	7.380+00
20	1	0.0000	5.5000+04	0.0000	0.0000	1.00000+00	4.0779-01	0.0000	0.0000	0.0000	7.180+00
19	1	0.0000	5.5000+04	0.0000	0.0000	1.00000+00	4.0779-01	0.0000	0.0000	0.0000	6.980+00
18	1	0.0000	5.5000+04	0.0000	0.0000	1.00000+00	4.0779-01	0.0000	0.0000	0.0000	6.780+00

```
17    1   0.0000   5.5000+04  0.0000     0.0000   1.00000+00  4.0779-01  0.0000       0.0000        0.0000     6.580+00
16    1   0.0000   5.5000+04  0.0000     0.0000   1.00000+00  4.0779-01  0.0000       0.0000        0.0000     6.380+00
15    1   0.0000   5.5000+04  0.0000     0.0000   1.00000+00  4.4857-01  0.0000       0.0000        0.0000     6.180+00
14    1   0.0000   5.5000+04  0.0000     0.0000   1.00000+00  4.8935-01  0.0000       0.0000        0.0000     5.960+00
13    1   0.0000   5.5000+04  0.0000     0.0000   1.00000+00  5.5052-01  0.0000       0.0000        0.0000     5.720+00
12    1   0.0000   5.5000+04  0.0000     0.0000   1.00000+00  5.9130-01  0.0000       0.0000        0.0000     5.450+00
11    1   0.0000   5.5000+04  0.0000     0.0000   1.00000+00  6.5247-01  0.0000       0.0000        0.0000     5.160+00
10    1   0.0000   5.5000+04  0.0000     0.0000   1.00000+00  7.1363-01  0.0000       0.0000        0.0000     4.840+00
 9    1   0.0000   5.5000+04  0.0000     0.0000   1.00000+00  7.9519-01  0.0000       0.0000        0.0000     4.490+00
 8    1   0.0000   5.5000+04  0.0000     0.0000   1.00000+00  8.7675-01  0.0000       0.0000        0.0000     4.100+00
 7    1   0.0000   5.5000+04  0.0000     0.0000   1.00000+00  9.5831-01  0.0000       0.0000        0.0000     3.670+00
 6    1   0.0000   5.5000+04  0.0000     0.0000   1.00000+00  1.0603+00  0.0000       0.0000        0.0000     3.200+00
 5    1   0.0000   5.5000+04  0.0000     0.0000   1.00000+00  1.1622+00  0.0000       0.0000        0.0000     2.680+00
 4    1   0.0000   5.5000+04  0.0000     0.0000   1.00000+00  1.2845+00  0.0000       0.0000        0.0000     2.110+00
 3    1   0.0000   5.5000+04  0.0000     0.0000   1.00000+00  1.3049+00  0.0000       0.0000        0.0000     1.480+00
 2  101   0.0000   5.5000+04  0.0000     0.0000   0.00000     1.3047+00  0.0000       0.0000        0.0000     8.400-01
   NMAT     US        VS        RHO        SIE       COMP        MASS    FRAC. VOL.   RHO(NVOID)=1.0  THETA= -1.00
      1   0.0000   5.5000+04  1.9170+01  0.0000   1.00000+00  1.3047+00  9.99844-01
      3   0.0000   0.0000     0.0000     0.0000   0.00000     0.0000     0.00000

 J  MFLAG   U          V          P          SIE       COMP       TMASS      SZZ          SRR           SRZ          Z

 1    0   0.0000   0.0000     0.0000     0.0000   0.00000     0.0000     0.0000       0.0000        0.0000     2.000-01
-----------------------------------------------------------------------------------------------------------------------
I =  2    R(I) = 3.6800-01   DR(I) = 1.8400000-01   TAU(I) = 3.1908529-01   T = 0.0000000     CYCLE =   0
-----------------------------------------------------------------------------------------------------------------------
 J  MFLAG   U          V          P          SIE       COMP       TMASS      SZZ          SRR           SRZ          Z

37    2   0.0000   0.0000     0.0000     0.0000   1.00000+00  4.9777-01  0.0000       0.0000        0.0000     1.058+01
36    2   0.0000   0.0000     0.0000     0.0000   1.00000+00  4.9777-01  0.0000       0.0000        0.0000     1.038+01
35  141   0.0000   0.0000     0.0000     0.0000   0.00000     4.9777-01  0.0000       0.0000        0.0000     1.018+01
   NMAT     US        VS        RHO        SIE       COMP        MASS    FRAC. VOL.   RHO(NVOID)=1.0  THETA= -1.00
      1   0.0000   0.0000     1.9170+01  0.0000   1.00000+00  0.0000     0.00000
      3   0.0000   0.0000     7.8000+00  0.0000   1.00000+00  4.9777-01  9.99996-01

 J  MFLAG   U          V          P          SIE       COMP       TMASS      SZZ          SRR           SRZ          Z

34  140   0.0000   5.5000+04  0.0000     0.0000   0.00000     7.2231-01  0.0000       0.0000        0.0000     9.980+00
   NMAT     US        VS        RHO        SIE       COMP        MASS    FRAC. VOL.   RHO(NVOID)=1.0  THETA= -1.00
      1   0.0000   5.5000+04  1.9170+01  0.0000   1.00000+00  7.2231-01  5.90423-01
      3   0.0000   0.0000     0.0000     0.0000   0.00000     0.0000     0.00000

 J  MFLAG   U          V          P          SIE       COMP       TMASS      SZZ          SRR           SRZ          Z

33  139   0.0000   5.5000+04  0.0000     0.0000   0.00000     9.9745-01  0.0000       0.0000        0.0000     9.780+00
   NMAT     US        VS        RHO        SIE       COMP        MASS    FRAC. VOL.   RHO(NVOID)=1.0  THETA= -1.00
      1   0.0000   5.5000+04  1.9170+01  0.0000   1.00000+00  9.9745-01  8.15324-01
      3   0.0000   0.0000     0.0000     0.0000   0.00000     0.0000     0.00000

 J  MFLAG   U          V          P          SIE       COMP       TMASS      SZZ          SRR           SRZ          Z

32  138   0.0000   5.5000+04  0.0000     0.0000   0.00000     1.2134+00  0.0000       0.0000        0.0000     9.580+00
   NMAT     US        VS        RHO        SIE       COMP        MASS    FRAC. VOL.   RHO(NVOID)=1.0  THETA= -1.00
```

1	0.0000	5.5000+04	1.9170+01	0.0000	1.00000+00	1.2134+00	9.91841-01
3	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.00000

J	MFLAG	U	V	P	SIE	COMP	TMASS	SZZ	SRR	SRZ	Z
31	1	0.0000	5.5000+04	0.0000	0.0000	1.00000+00	1.2234+00	0.0000	0.0000	0.0000	9.380+0
30	1	0.0000	5.5000+04	0.0000	0.0000	1.00000+00	1.2234+00	0.0000	0.0000	0.0000	9.180+0
29	1	0.0000	5.5000+04	0.0000	0.0000	1.00000+00	1.2234+00	0.0000	0.0000	0.0000	8.960+0
28	1	0.0000	5.5000+04	0.0000	0.0000	1.00000+00	1.2234+00	0.0000	0.0000	0.0000	8.780+0
27	1	0.0000	5.5000+04	0.0000	0.0000	1.00000+00	1.2234+00	0.0000	0.0000	0.0000	8.580+0
26	1	0.0000	5.5000+04	0.0000	0.0000	1.00000+00	1.2234+00	0.0000	0.0000	0.0000	8.380+0
25	1	0.0000	5.5000+04	0.0000	0.0000	1.00000+00	1.2234+00	0.0000	0.0000	0.0000	8.180+0
24	1	0.0000	5.5000+04	0.0000	0.0000	1.00000+00	1.2234+00	0.0000	0.0000	0.0000	7.980+0
23	1	0.0000	5.5000+04	0.0000	0.0000	1.00000+00	1.2234+00	0.0000	0.0000	0.0000	7.780+0
22	1	0.0000	5.5000+04	0.0000	0.0000	1.00000+00	1.2234+00	0.0000	0.0000	0.0000	7.580+0
21	1	0.0000	5.5000+04	0.0000	0.0000	1.00000+00	1.2234+00	0.0000	0.0000	0.0000	7.380+0
20	1	0.0000	5.5000+04	0.0000	0.0000	1.00000+00	1.2234+00	0.0000	0.0000	0.0000	7.180+0
19	1	0.0000	5.5000+04	0.0000	0.0000	1.00000+00	1.2234+00	0.0000	0.0000	0.0000	6.980+0
18	1	0.0000	5.5000+04	0.0000	0.0000	1.00000+00	1.2234+00	0.0000	0.0000	0.0000	6.780+0
17	1	0.0000	5.5000+04	0.0000	0.0000	1.00000+00	1.2234+00	0.0000	0.0000	0.0000	6.580+0
16	1	0.0000	5.5000+04	0.0000	0.0000	1.00000+00	1.2234+00	0.0000	0.0000	0.0000	6.380+0
15	1	0.0000	5.5000+04	0.0000	0.0000	1.00000+00	1.3457+00	0.0000	0.0000	0.0000	6.180+0
14	1	0.0000	5.5000+04	0.0000	0.0000	1.00000+00	1.4680+00	0.0000	0.0000	0.0000	5.960+0
13	1	0.0000	5.5000+04	0.0000	0.0000	1.00000+00	1.6516+00	0.0000	0.0000	0.0000	5.720+0
12	1	0.0000	5.5000+04	0.0000	0.0000	1.00000+00	1.7739+00	0.0000	0.0000	0.0000	5.450+0
11	1	0.0000	5.5000+04	0.0000	0.0000	1.00000+00	1.9574+00	0.0000	0.0000	0.0000	5.160+0
10	1	0.0000	5.5000+04	0.0000	0.0000	1.00000+00	2.1409+00	0.0000	0.0000	0.0000	4.840+0
9	1	0.0000	5.5000+04	0.0000	0.0000	1.00000+00	2.3856+00	0.0000	0.0000	0.0000	4.490+0
8	1	0.0000	5.5000+04	0.0000	0.0000	1.00000+00	2.6303+00	0.0000	0.0000	0.0000	4.100+0
7	1	0.0000	5.5000+04	0.0000	0.0000	1.00000+00	2.8749+00	0.0000	0.0000	0.0000	3.670+0
6	1	0.0000	5.5000+04	0.0000	0.0000	1.00000+00	3.1808+00	0.0000	0.0000	0.0000	3.200+0
5	1	0.0000	5.5000+04	0.0000	0.0000	1.00000+00	3.4866+00	0.0000	0.0000	0.0000	2.680+0
4	1	0.0000	5.5000+04	0.0000	0.0000	1.00000+00	3.8536+00	0.0000	0.0000	0.0000	2.110+0
3	1	0.0000	5.5000+04	0.0000	0.0000	1.00000+00	3.9148+00	0.0000	0.0000	0.0000	1.480+0
2	102	0.0000	5.5000+04	0.0000	0.0000	0.00000	3.9142+00	0.0000	0.0000	0.0000	8.400-0

	NMAT	US	VS	RHO	SIE	COMP	MASS	FRAC. VOL.	RHO(NVOID)=1.0	THETA= -1.0
	1	0.0000	5.5000+04	1.9170+01	0.0000	1.00000+00	3.9142+00	9.99844-01		
	3	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.00000		

J	MFLAG	U	V	P	SIE	COMP	TMASS	SZZ	SRR	SRZ	Z
1	0	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.0000	0.0000	0.0000	2.000-0

I = 3 R(I) = 5.5200-01 DR(I) = 1.8400000-01 TAU(I) = 5.3180881-01 T = 0.0000000 CYCLE = 0

J	MFLAG	U	V	P	SIE	COMP	TMASS	SZZ	SRR	SRZ	Z
37	2	0.0000	0.0000	0.0000	0.0000	1.00000+00	8.2962-01	0.0000	0.0000	0.0000	1.058+0
36	2	0.0000	0.0000	0.0000	0.0000	1.00000+00	8.2962-01	0.0000	0.0000	0.0000	1.038+0
35	143	0.0000	0.0000	0.0000	0.0000	0.00000	8.2962-01	0.0000	0.0000	0.0000	1.018+0

	NMAT	US	VS	RHO	SIE	COMP	MASS	FRAC. VOL.	RHO(NVOID)=1.0	THETA= -1.0
	1	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.00000		
	3	0.0000	0.0000	7.8000+00	0.0000	1.00000+00	8.2962-01	9.99995-01		

J	MFLAG	U	V	P	SIE	COMP	TMASS	SZZ	SRR	SRZ	Z
34	0	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.0000	0.0000	0.0000	9.980+00
33	0	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.0000	0.0000	0.0000	9.780+00
32	137	0.0000	5.5000+04	0.0000	0.0000	0.00000	8.9168-02	0.0000	0.0000	0.0000	9.580+00
	NMAT	US	VS	RHO	SIE	COMP	MASS	FRAC. VOL.	RHO(NVOID)=1.0		THETA= -1.00
	1	0.0000	5.5000+04	1.9170+01	0.0000	1.00000+00	8.9168-02	4.37322-02			
	3	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.00000			
J	MFLAG	U	V	P	SIE	COMP	TMASS	SZZ	SRR	SRZ	Z
31	136	0.0000	5.5000+04	0.0000	0.0000	0.00000	4.1428-01	0.0000	0.0000	0.0000	9.380+00
	NMAT	US	VS	RHO	SIE	COMP	MASS	FRAC. VOL.	RHO(NVOID)=1.0		THETA= -1.00
	1	0.0000	5.5000+04	1.9170+01	0.0000	1.00000+00	4.1428-01	2.03181-01			
	3	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.00000			
J	MFLAG	U	V	P	SIE	COMP	TMASS	SZZ	SRR	SRZ	Z
30	135	0.0000	5.5000+04	0.0000	0.0000	0.00000	7.7935-01	0.0000	0.0000	0.0000	9.180+00
	NMAT	US	VS	RHO	SIE	COMP	MASS	FRAC. VOL.	RHO(NVOID)=1.0		THETA= -1.00
	1	0.0000	5.5000+04	1.9170+01	0.0000	1.00000+00	7.7935-01	3.82228-01			
	3	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.00000			
J	MFLAG	U	V	P	SIE	COMP	TMASS	SZZ	SRR	SRZ	Z
29	134	0.0000	5.5000+04	0.0000	0.0000	0.00000	1.1744+00	0.0000	0.0000	0.0000	8.980+00
	NMAT	US	VS	RHO	SIE	COMP	MASS	FRAC. VOL.	RHO(NVOID)=1.0		THETA= -1.00
	1	0.0000	5.5000+04	1.9170+01	0.0000	1.00000+00	1.1744+00	5.75976-01			
	3	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.00000			
J	MFLAG	U	V	P	SIE	COMP	TMASS	SZZ	SRR	SRZ	Z
28	133	0.0000	5.5000+04	0.0000	0.0000	0.00000	1.5994+00	0.0000	0.0000	0.0000	8.780+00
	NMAT	US	VS	RHO	SIE	COMP	MASS	FRAC. VOL.	RHO(NVOID)=1.0		THETA= -1.00
	1	0.0000	5.5000+04	1.9170+01	0.0000	1.00000+00	1.5994+00	7.84426-01			
	3	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.00000			
J	MFLAG	U	V	P	SIE	COMP	TMASS	SZZ	SRR	SRZ	Z
27	132	0.0000	5.5000+04	0.0000	0.0000	0.00000	1.9877+00	0.0000	0.0000	0.0000	8.580+00
	NMAT	US	VS	RHO	SIE	COMP	MASS	FRAC. VOL.	RHO(NVOID)=1.0		THETA= -1.00
	1	0.0000	5.5000+04	1.9170+01	0.0000	1.00000+00	1.9877+00	9.74870-01			
	3	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.00000			
J	MFLAG	U	V	P	SIE	COMP	TMASS	SZZ	SRR	SRZ	Z
26	1	0.0000	5.5000+04	0.0000	0.0000	1.00000+00	2.0390+00	0.0000	0.0000	0.0000	8.380+00
25	1	0.0000	5.5000+04	0.0000	0.0000	1.00000+00	2.0390+00	0.0000	0.0000	0.0000	8.180+00
24	1	0.0000	5.5000+04	0.0000	0.0000	1.00000+00	2.0390+00	0.0000	0.0000	0.0000	7.980+00
23	1	0.0000	5.5000+04	0.0000	0.0000	1.00000+00	2.0390+00	0.0000	0.0000	0.0000	7.780+00
22	1	0.0000	5.5000+04	0.0000	0.0000	1.00000+00	2.0390+00	0.0000	0.0000	0.0000	7.580+00
21	1	0.0000	5.5000+04	0.0000	0.0000	1.00000+00	2.0390+00	0.0000	0.0000	0.0000	7.380+00
20	1	0.0000	5.5000+04	0.0000	0.0000	1.00000+00	2.0390+00	0.0000	0.0000	0.0000	7.180+00

19	1	0.0000	5.5000+04	0.0000	0.0000	1.00000+00	2.0390+00	0.0000	0.0000	0.0000	6.980+0
18	1	0.0000	5.5000+04	0.0000	0.0000	1.00000+00	2.0390+00	0.0000	0.0000	0.0000	6.780+0
17	1	0.0000	5.5000+04	0.0000	0.0000	1.00000 00	2.03 0 00	0.0000	0.0000	0.0000	[illegible]
16	1	0.0000	5.5000+04	0.0000	0.0000	1.00000+00	2.0390+00	0.0000	0.0000	0.0000	6.380+0
15	1	0.0000	5.5000+04	0.0000	0.0000	1.00000+00	2.2429+00	0.0000	0.0000	0.0000	6.180+0
14	1	0.0000	5.5000+04	0.0000	0.0000	1.00000+00	2.4467+00	0.0000	0.0000	0.0000	5.960+0
13	1	0.0000	5.5000+04	0.0000	0.0000	1.00000+00	2.7526+00	0.0000	0.0000	0.0000	5.720+0
12	1	0.0000	5.5000+04	0.0000	0.0000	1.00000+00	2.9565+00	0.0000	0.0000	0.0000	5.450+0
11	1	0.0000	5.5000+04	0.0000	0.0000	1.00000 00	3.2623 00	0.0000	0.0000	0.0000	5.160+0
10	1	0.0000	5.5000+04	0.0000	0.0000	1.00000+00	3.5682+00	0.0000	0.0000	0.0000	4.840+0
9	1	0.0000	5.5000+04	0.0000	0.0000	1.00000+00	3.9760+00	0.0000	0.0000	0.0000	4.490+0
8	1	0.0000	5.5000+04	0.0000	0.0000	1.00000+00	4.3838+00	0.0000	0.0000	0.0000	4.100+0
7	1	0.0000	5.5000+04	0.0000	0.0000	1.00000+00	4.7915+00	0.0000	0.0000	0.0000	3.670+0
6	1	0.0000	5.5000+04	0.0000	0.0000	1.00000+00	5.3013+00	0.0000	0.0000	0.0000	3.200+0
5	1	0.0000	5.5000+04	0.0000	0.0000	1.00000+00	5.8110+00	0.0000	0.0000	0.0000	2.680+0
4	1	0.0000	5.5000+04	0.0000	0.0000	1.00000+00	6.4227+00	0.0000	0.0000	0.0000	2.110+0
3	1	0.0000	5.5000+04	0.0000	0.0000	1.00000+00	6.5247+00	0.0000	0.0000	0.0000	1.480+0
2	103	0.0000	5.5000+04	0.0000	0.0000	0.00000	6.5236+00	0.0000	0.0000	0.0000	8.400-0

NMAT	US	VS	RHO	SIE	COMP	MASS	FRAC. VOL.	RHO(NVOID)=1.0 THETA= -1.0
1	0.0000	5.5000+04	1.9170+01	0.0000	1.00000+00	6.5236+00	9.99844-01	
3	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.00000	

J	MFLAG	U	V	P	SIE	COMP	TMASS	SZZ	SRR	SRZ	Z
1	0	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.0000	0.0000	0.0000	2.000-0

I = 4 R(I) = 7.3600-01 DR(I) = 1.8400000-01 TAU(I) = 7.4453234-01 T = 0.0000000 CYCLE = 0

J	MFLAG	U	V	P	SIE	COMP	TMASS	SZZ	SRR	SRZ	Z
37	2	0.0000	0.0000	0.0000	0.0000	1.00000+00	1.1615+00	0.0000	0.0000	0.0000	1.058+0
36	2	0.0000	0.0000	0.0000	0.0000	1.00000+00	1.1615+00	0.0000	0.0000	0.0000	1.038+0
35	144	0.0000	0.0000	0.0000	0.0000	0.00000	1.1615+00	0.0000	0.0000	0.0000	1.018+0

NMAT	US	VS	RHO	SIE	COMP	MASS	FRAC. VOL.	RHO(NVOID)=1.0 THETA= -1.0
1	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.00000	
3	0.0000	0.0000	7.8000+00	0.0000	1.00000+00	1.1615+00	9.99995-01	

J	MFLAG	U	V	P	SIE	COMP	TMASS	SZZ	SRR	SRZ	Z
34	0	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.0000	0.0000	0.0000	9.980+0
33	0	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.0000	0.0000	0.0000	9.780+0
32	0	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.0000	0.0000	0.0000	9.580+0
31	0	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.0000	0.0000	0.0000	9.380+0
30	0	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.0000	0.0000	0.0000	9.180+0
29	0	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.0000	0.0000	0.0000	8.980+0
28	0	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.0000	0.0000	0.0000	8.780+0
27	131	0.0000	5.5000+04	0.0000	0.0000	0.00000	6.6688-02	0.0000	0.0000	0.0000	8.580+0

NMAT	US	VS	RHO	SIE	COMP	MASS	FRAC. VOL.	RHO(NVOID)=1.0 THETA= -1.0
1	0.0000	5.5000+04	1.9170+01	0.0000	1.00000+00	6.6688-02	2.33622-02	
3	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.00000	

J	MFLAG	U	V	P	SIE	COMP	TMASS	SZZ	SRR	SRZ	Z

```
26   130    0.0000    5.5000+04   0.0000     0.0000     0.00000      5.0042-01   0.0000       0.0000      0.0000     8.380+00
     NMAT     US         VS         RHU        SIE        COMP         MASS     FRAC. VOL.     RHO(NVOID)=1.0   THETA= -1.00
       1    0.0000    5.5000+04   1.9170+01  0.0000     1.00000+00   5.0042-01   1.75308-01
       3    0.0000    0.0000      0.0000     0.0000     0.00000      0.0000      0.00000

 J  MFLAG     U          V          P         SIE        COMP        TMASS        SZZ          SRR         SRZ        Z

25   129    0.0000    5.5000+04   0.0000     0.0000     0.00000      1.0154+00   0.0000       0.0000      0.0000     8.180+00
     NMAT     US         VS         RHU        SIE        COMP         MASS     FRAC. VOL.     RHO(NVOID)=1.0   THETA= -1.00
       1    0.0000    5.5000+04   1.9170+01  0.0000     1.00000+00   1.0154+00   3.55705-01
       3    0.0000    0.0000      0.0000     0.0000     0.00000      0.0000      0.00000

 J  MFLAG     U          V          P         SIE        COMP        TMASS        SZZ          SRR         SRZ        Z

24   128    0.0000    5.5000+04   0.0000     0.0000     0.00000      1.5603+00   0.0000       0.0000      0.0000     7.980+00
     NMAT     US         VS         RHU        SIE        COMP         MASS     FRAC. VOL.     RHO(NVOID)=1.0   THETA= -1.00
       1    0.0000    5.5000+04   1.9170+01  0.0000     1.00000+00   1.5603+00   5.46604-01
       3    0.0000    0.0000      0.0000     0.0000     0.00000      0.0000      0.00000

 J  MFLAG     U          V          P         SIE        COMP        TMASS        SZZ          SRR         SRZ        Z

23   127    0.0000    5.5000+04   0.0000     0.0000     0.00000      2.1352+00   0.0000       0.0000      0.0000     7.780+00
     NMAT     US         VS         RHU        SIE        COMP         MASS     FRAC. VOL.     RHO(NVOID)=1.0   THETA= -1.00
       1    0.0000    5.5000+04   1.9170+01  0.0000     1.00000+00   2.1352+00   7.48003-01
       3    0.0000    0.0000      0.0000     0.0000     0.00000      0.0000      0.00000

 J  MFLAG     U          V          P         SIE        COMP        TMASS        SZZ          SRR         SRZ        Z

22   126    0.0000    5.5000+04   0.0000     0.0000     0.00000      2.7091+00   0.0000       0.0000      0.0000     7.580+00
     NMAT     US         VS         RHU        SIE        COMP         MASS     FRAC. VOL.     RHO(NVOID)=1.0   THETA= -1.00
       1    0.0000    5.5000+04   1.9170+01  0.0000     1.00000+00   2.7091+00   9.49036-01
       3    0.0000    0.0000      0.0000     0.0000     0.00000      0.0000      0.00000

 J  MFLAG     U          V          P         SIE        COMP        TMASS        SZZ          SRR         SRZ        Z

21     1    0.0000    5.5000+04   0.0000     0.0000     1.00000+00   2.8545+00   0.0000       0.0000      0.0000     7.380+00
20     1    0.0000    5.5000+04   0.0000     0.0000     1.00000+00   2.8545+00   0.0000       0.0000      0.0000     7.180+00
19     1    0.0000    5.5000+04   0.0000     0.0000     1.00000+00   2.8545+00   0.0000       0.0000      0.0000     6.980+00
18     1    0.0000    5.5000+04   0.0000     0.0000     1.00000+00   2.8545+00   0.0000       0.0000      0.0000     6.780+00
17     1    0.0000    5.5000+04   0.0000     0.0000     1.00000+00   2.8545+00   0.0000       0.0000      0.0000     6.580+00
16     1    0.0000    5.5000+04   0.0000     0.0000     1.00000+00   2.8545+00   0.0000       0.0000      0.0000     6.380+00
15     1    0.0000    5.5000+04   0.0000     0.0000     1.00000+00   3.1400+00   0.0000       0.0000      0.0000     6.180+00
14     1    0.0000    5.5000+04   0.0000     0.0000     1.00000+00   3.4254+00   0.0000       0.0000      0.0000     5.960+00
13     1    0.0000    5.5000+04   0.0000     0.0000     1.00000+00   3.8536+00   0.0000       0.0000      0.0000     5.720+00
12     1    0.0000    5.5000+04   0.0000     0.0000     1.00000+00   4.1391+00   0.0000       0.0000      0.0000     5.450+00
11     1    0.0000    5.5000+04   0.0000     0.0000     1.00000+00   4.5673+00   0.0000       0.0000      0.0000     5.160+00
10     1    0.0000    5.5000+04   0.0000     0.0000     1.00000+00   4.9954+00   0.0000       0.0000      0.0000     4.840+00
 9     1    0.0000    5.5000+04   0.0000     0.0000     1.00000+00   5.5663+00   0.0000       0.0000      0.0000     4.490+00
 8     1    0.0000    5.5000+04   0.0000     0.0000     1.00000+00   6.1373+00   0.0000       0.0000      0.0000     4.100+00
 7     1    0.0000    5.5000+04   0.0000     0.0000     1.00000+00   6.7082+00   0.0000       0.0000      0.0000     3.670+00
 6     1    0.0000    5.5000+04   0.0000     0.0000     1.00000+00   7.4218+00   0.0000       0.0000      0.0000     3.200+00
 5     1    0.0000    5.5000+04   0.0000     0.0000     1.00000+00   8.1354+00   0.0000       0.0000      0.0000     2.680+00
 4     1    0.0000    5.5000+04   0.0000     0.0000     1.00000+00   8.9918+00   0.0000       0.0000      0.0000     2.110+00
 3     1    0.0000    5.5000+04   0.0000     0.0000     1.00000+00   9.1345+00   0.0000       0.0000      0.0000     1.480+00
```

```
  2   104    0.0000      5.5000+04   0.0000     0.0000     0.00000      9.1331+00   0.0000      0.0000      0.0000     [illegible]
     NMAT      US           VS         RHO        SIE        COMP         MASS     FRAC. VOL.    RHO(NVOID)=1.0  THETA= -1.00
        1    0.0000      5.5000+04   1.9170+01  0.0000     1.00000+00   9.1331+00   9.99844-01
        3    0.0000      0.0000      0.0000     0.0000     0.00000      0.0000      0.00000

  J  MFLAG      U           V           P         SIE        COMP        TMASS        SZZ         SRR         SRZ          Z

  1     0    0.0000      0.0000      0.0000     0.0000     0.00000      0.0000      0.0000      0.0000      0.0000     2.000-01
-------------------------------------------------------------------------------------------------------------------------------
I =   5      R(I) = 9.3600-01        DR(I) = 2.0000000-01       TAU(I) = 1.0505486+00        T = 0.0000000           CYCLE =    0
-------------------------------------------------------------------------------------------------------------------------------

  J  MFLAG      U           V           P         SIE        COMP        TMASS        SZZ         SRR         SRZ          Z

 37     2    0.0000      0.0000      0.0000     0.0000     1.00000+00   1.6389+00   0.0000      0.0000      0.0000     1.058+01
 36     2    0.0000      0.0000      0.0000     0.0000     1.00000+00   1.6389+00   0.0000      0.0000      0.0000     1.038+01
 35   145    0.0000      0.0000      0.0000     0.0000     0.00000      1.6388+00   0.0000      0.0000      0.0000     1.018+01
     NMAT      US           VS         RHO        SIE        COMP         MASS     FRAC. VOL.    RHO(NVOID)=1.0  THETA= -1.00
        1    0.0000      0.0000      0.0000     0.0000     0.00000      0.0000      0.00000
        3    0.0000      0.0000      7.8000+00  0.0000     1.00000+00   1.6388+00   9.99995-01

  J  MFLAG      U           V           P         SIE        COMP        TMASS        SZZ         SRR         SRZ          Z

 34     0    0.0000      0.0000      0.0000     0.0000     0.00000      0.0000      0.0000      0.0000      0.0000     9.980+00
 33     0    0.0000      0.0000      0.0000     0.0000     0.00000      0.0000      0.0000      0.0000      0.0000     9.780+00
 32     0    0.0000      0.0000      0.0000     0.0000     0.00000      0.0000      0.0000      0.0000      0.0000     9.580+00
 31     0    0.0000      0.0000      0.0000     0.0000     0.00000      0.0000      0.0000      0.0000      0.0000     9.380+00
 30     0    0.0000      0.0000      0.0000     0.0000     0.00000      0.0000      0.0000      0.0000      0.0000     9.180+00
 29     0    0.0000      0.0000      0.0000     0.0000     0.00000      0.0000      0.0000      0.0000      0.0000     8.980+00
 28     0    0.0000      0.0000      0.0000     0.0000     0.00000      0.0000      0.0000      0.0000      0.0000     8.780+00
 27     0    0.0000      0.0000      0.0000     0.0000     0.00000      0.0000      0.0000      0.0000      0.0000     8.580+00
 26     0    0.0000      0.0000      0.0000     0.0000     0.00000      0.0000      0.0000      0.0000      0.0000     8.380+00
 25     0    0.0000      0.0000      0.0000     0.0000     0.00000      0.0000      0.0000      0.0000      0.0000     8.180+00
 24     0    0.0000      0.0000      0.0000     0.0000     0.00000      0.0000      0.0000      0.0000      0.0000     7.980+00
 23     0    0.0000      0.0000      0.0000     0.0000     0.00000      0.0000      0.0000      0.0000      0.0000     7.780+00
 22   125    0.0000      5.5000+04   0.0000     0.0000     0.00000      2.7232-03   0.0000      0.0000      0.0000     7.580+00
     NMAT      US           VS         RHO        SIE        COMP         MASS     FRAC. VOL.    RHO(NVOID)=1.0  THETA= -1.00
        1    0.0000      5.5000+04   1.9170+01  0.0000     1.00000+00   2.7232-03   6.76105-04
        3    0.0000      0.0000      0.0000     0.0000     0.00000      0.0000      0.00000

  J  MFLAG      U           V           P         SIE        COMP        TMASS        SZZ         SRR         SRZ          Z

 21   124    0.0000      5.5000+04   0.0000     0.0000     0.00000      8.8679-03   0.0000      0.0000      0.0000     7.380+00
     NMAT      US           VS         RHO        SIE        COMP         MASS     FRAC. VOL.    RHO(NVOID)=1.0  THETA= -1.00
        1    0.0000      5.5000+04   1.9170+01  0.0000     1.00000+00   8.8679-03   2.20168-03
        3    0.0000      0.0000      0.0000     0.0000     0.00000      0.0000      0.00000

  J  MFLAG      U           V           P         SIE        COMP        TMASS        SZZ         SRR         SRZ          Z

 20   123    0.0000      5.5000+04   0.0000     0.0000     0.00000      8.8679-03   0.0000      0.0000      0.0000     7.180+00
     NMAT      US           VS         RHO        SIE        COMP         MASS     FRAC. VOL.    RHO(NVOID)=1.0  THETA= -1.00
        1    0.0000      5.5000+04   1.9170+01  0.0000     1.00000+00   8.8679-03   2.20168-03
        3    0.0000      0.0000      0.0000     0.0000     0.00000      0.0000      0.00000
```

J	MFLAG	U	V	P	SIE	COMP	TMASS	SZZ	SRR	SRZ	Z
19	122	0.0000	5.5000+04	0.0000	0.0000	0.00000	8.8679-03	0.0000	0.0000	0.0000	6.980+00
	NMAT	US	VS	RHO	SIE	COMP	MASS	FRAC. VOL.	RHO(NVOID)=1.0	THETA=	-1.00
	1	0.0000	5.5000+04	1.9170+01	0.0000	1.00000+00	8.8679-03	2.20166-03			
	3	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.00000			

J	MFLAG	U	V	P	SIE	COMP	TMASS	SZZ	SRR	SRZ	Z
18	121	0.0000	5.5000+04	0.0000	0.0000	0.00000	8.8679-03	0.0000	0.0000	0.0000	6.780+00
	NMAT	US	VS	RHO	SIE	COMP	MASS	FRAC. VOL.	RHO(NVOID)=1.0	THETA=	-1.00
	1	0.0000	5.5000+04	1.9170+01	0.0000	1.00000+00	8.8679-03	2.20168-03			
	3	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.00000			

J	MFLAG	U	V	P	SIE	COMP	TMASS	SZZ	SRR	SRZ	Z
17	120	0.0000	5.5000+04	0.0000	0.0000	0.00000	8.8679-03	0.0000	0.0000	0.0000	6.580+00
	NMAT	US	VS	RHO	SIE	COMP	MASS	FRAC. VOL.	RHO(NVOID)=1.0	THETA=	-1.00
	1	0.0000	5.5000+04	1.9170+01	0.0000	1.00000+00	8.8679-03	2.20168-03			
	3	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.00000			

J	MFLAG	U	V	P	SIE	COMP	TMASS	SZZ	SRR	SRZ	Z
16	119	0.0000	5.5000+04	0.0000	0.0000	0.00000	8.8679-03	0.0000	0.0000	0.0000	6.380+00
	NMAT	US	VS	RHO	SIE	COMP	MASS	FRAC. VOL.	RHO(NVOID)=1.0	THETA=	-1.00
	1	0.0000	5.5000+04	1.9170+01	0.0000	1.00000+00	8.8679-03	2.20168-03			
	3	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.00000			

J	MFLAG	U	V	P	SIE	COMP	TMASS	SZZ	SRR	SRZ	Z
15	118	0.0000	5.5000+04	0.0000	0.0000	0.00000	9.7547-03	0.0000	0.0000	0.0000	6.180+00
	NMAT	US	VS	RHO	SIE	COMP	MASS	FRAC. VOL.	RHO(NVOID)=1.0	THETA=	-1.00
	1	0.0000	5.5000+04	1.9170+01	0.0000	1.00000+00	9.7547-03	2.20168-03			
	3	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.00000			

J	MFLAG	U	V	P	SIE	COMP	TMASS	SZZ	SRR	SRZ	Z
14	117	0.0000	5.5000+04	0.0000	0.0000	0.00000	1.0642-02	0.0000	0.0000	0.0000	5.960+00
	NMAT	US	VS	RHO	SIE	COMP	MASS	FRAC. VOL.	RHO(NVOID)=1.0	THETA=	-1.00
	1	0.0000	5.5000+04	1.9170+01	0.0000	1.00000+00	1.0642-02	2.20168-03			
	3	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.00000			

J	MFLAG	U	V	P	SIE	COMP	TMASS	SZZ	SRR	SRZ	Z
13	116	0.0000	5.5000+04	0.0000	0.0000	0.00000	1.1972-02	0.0000	0.0000	0.0000	5.720+00
	NMAT	US	VS	RHO	SIE	COMP	MASS	FRAC. VOL.	RHO(NVOID)=1.0	THETA=	-1.00
	1	0.0000	5.5000+04	1.9170+01	0.0000	1.00000+00	1.1972-02	2.20168-03			
	3	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.00000			

J	MFLAG	U	V	P	SIE	COMP	TMASS	SZZ	SRR	SRZ	Z
12	115	0.0000	5.5000+04	0.0000	0.0000	0.00000	1.2858-02	0.0000	0.0000	0.0000	5.450+00
	NMAT	US	VS	RHO	SIE	COMP	MASS	FRAC. VOL.	RHO(NVOID)=1.0	THETA=	-1.00
	1	0.0000	5.5000+04	1.9170+01	0.0000	1.00000+00	1.2858-02	2.20168-03			

```
        3   0.0000     0.0000    0.0000    0.0000    0.00000     0.0000     0.00000

 J  MFLAG     U          V         P        SIE       COMP       TMASS       SZZ         SRR         SRZ         Z

11   114    0.0000     5.5000+04  0.0000    0.0000    0.00000    1.4189-02   0.0000      0.0000      0.0000     5.160+0
     NMAT     US         VS        RHO       SIE       COMP       MASS      FRAC. VOL.   RHO(NVOID)=1.0  THETA= -1.0
        1   0.0000     5.5000+04  1.9170+01  0.0000   1.00000+00  1.4189-02   2.20166-03
        3   0.0000     0.0000     0.0000    0.0000    0.00000     0.0000     0.00000

 J  MFLAG     U          V         P        SIE       COMP       TMASS       SZZ         SRR         SRZ         Z

10   113    0.0000     5.5000+04  0.0000    0.0000    0.00000    1.5519-02   0.0000      0.0000      0.0000     4.840+0
     NMAT     US         VS        RHO       SIE       COMP       MASS      FRAC. VOL.   RHO(NVOID)=1.0  THETA= -1.0
        1   0.0000     5.5000+04  1.9170+01  0.0000   1.00000+00  1.5519-02   2.20167-03
        3   0.0000     0.0000     0.0000    0.0000    0.00000     0.0000     0.00000

 J  MFLAG     U          V         P        SIE       COMP       TMASS       SZZ         SRR         SRZ         Z

 9   112    0.0000     5.5000+04  0.0000    0.0000    0.00000    1.7293-02   0.0000      0.0000      0.0000     4.490+0
     NMAT     US         VS        RHO       SIE       COMP       MASS      FRAC. VOL.   RHO(NVOID)=1.0  THETA= -1.0
        1   0.0000     5.5000+04  1.9170+01  0.0000   1.00000+00  1.7293-02   2.20169-03
        3   0.0000     0.0000     0.0000    0.0000    0.00000     0.0000     0.00000

 J  MFLAG     U          V         P        SIE       COMP       TMASS       SZZ         SRR         SRZ         Z

 8   111    0.0000     5.5000+04  0.0000    0.0000    0.00000    1.9067-02   0.0000      0.0000      0.0000     4.100+0
     NMAT     US         VS        RHO       SIE       COMP       MASS      FRAC. VOL.   RHO(NVOID)=1.0  THETA= -1.0
        1   0.0000     5.5000+04  1.9170+01  0.0000   1.00000+00  1.9067-02   2.20179-03
        3   0.0000     0.0000     0.0000    0.0000    0.00000     0.0000     0.00000

 J  MFLAG     U          V         P        SIE       COMP       TMASS       SZZ         SRR         SRZ         Z

 7   110    0.0000     5.5000+04  0.0000    0.0000    0.00000    2.0839-02   0.0000      0.0000      0.0000     3.670+0
     NMAT     US         VS        RHO       SIE       COMP       MASS      FRAC. VOL.   RHO(NVOID)=1.0  THETA= -1.0
        1   0.0000     5.5000+04  1.9170+01  0.0000   1.00000+00  2.0839-02   2.20166-03
        3   0.0000     0.0000     0.0000    0.0000    0.00000     0.0000     0.00000

 J  MFLAG     U          V         P        SIE       COMP       TMASS       SZZ         SRR         SRZ         Z

 6   109    0.0000     5.5000+04  0.0000    0.0000    0.00000    2.3057-02   0.0000      0.0000      0.0000     3.200+0
     NMAT     US         VS        RHO       SIE       COMP       MASS      FRAC. VOL.   RHO(NVOID)=1.0  THETA= -1.0
        1   0.0000     5.5000+04  1.9170+01  0.0000   1.00000+00  2.3057-02   2.20168-03
        3   0.0000     0.0000     0.0000    0.0000    0.00000     0.0000     0.00000

 J  MFLAG     U          V         P        SIE       COMP       TMASS       SZZ         SRR         SRZ         Z

 5   108    0.0000     5.5000+04  0.0000    0.0000    0.00000    2.5273-02   0.0000      0.0000      0.0000     2.680+0
     NMAT     US         VS        RHO       SIE       COMP       MASS      FRAC. VOL.   RHO(NVOID)=1.0  THETA= -1.0
        1   0.0000     5.5000+04  1.9170+01  0.0000   1.00000+00  2.5273-02   2.20166-03
        3   0.0000     0.0000     0.0000    0.0000    0.00000     0.0000     0.00000

 J  MFLAG     U          V         P        SIE       COMP       TMASS       SZZ         SRR         SRZ         Z

 4   107    0.0000     5.5000+04  0.0000    0.0000    0.00000    2.7934-02   0.0000      0.0000      0.0000     2.110+0
```

```
      NMAT     US           VS           RHO          SIE          COMP          MASS         FRAC. VOL.     RHO(NVOID)=1.0  THETA= -1.00
        1    0.0000       5.5000+04    1.9170+01    0.0000       1.00000+00    2.7934-02     2.20166-03
        3    0.0000       0.0000       0.0000       0.0000       0.00000       0.0000        0.00000

  J   MFLAG    U            V            P            SIE          COMP          TMASS        SZZ           SRR           SRZ          Z

  3   106    0.0000       5.5000+04    0.0000       0.0000       0.00000       2.8377-02    0.0000        0.0000        0.0000       1.480+00
      NMAT     US           VS           RHO          SIE          COMP          MASS         FRAC. VOL.     RHO(NVOID)=1.0  THETA= -1.00
        1    0.0000       5.5000+04    1.9170+01    0.0000       1.00000+00    2.8377-02     2.20168-03
        3    0.0000       0.0000       0.0000       0.0000       0.00000       0.0000        0.00000

  J   MFLAG    U            V            P            SIE          COMP          TMASS        SZZ           SRR           SRZ          Z

  2   105    0.0000       5.5000+04    0.0000       0.0000       0.00000       2.8373-02    0.0000        0.0000        0.0000       8.400-01
      NMAT     US           VS           RHO          SIE          COMP          MASS         FRAC. VOL.     RHO(NVOID)=1.0  THETA= -1.00
        1    0.0000       5.5000+04    1.9170+01    0.0000       1.00000+00    2.8373-02     2.20133-03
        3    0.0000       0.0000       0.0000       0.0000       0.00000       0.0000        0.00000

  J   MFLAG    U            V            P            SIE          COMP          TMASS        SZZ           SRR           SRZ          Z

  1     0    0.0000       0.0000       0.0000       0.0000       0.00000       0.0000       0.0000        0.0000        0.0000       2.000-01
-------------------------------------------------------------------------------------------------------------------------------------------
 I =  6      R(I) = 1.1560+00         DR(I) = 2.2000000-01         TAU(I) = 1.4458866+00         T = 0.0000000           CYCLE =     0
-------------------------------------------------------------------------------------------------------------------------------------------

  J   MFLAG    U            V            P            SIE          COMP          TMASS        SZZ           SRR           SRZ          Z

 37     2    0.0000       0.0000       0.0000       0.0000       1.00000+00    2.2556+00    0.0000        0.0000        0.0000       1.058+01
 36     2    0.0000       0.0000       0.0000       0.0000       1.00000+00    2.2556+00    0.0000        0.0000        0.0000       1.038+01
 35   146    0.0000       0.0000       0.0000       0.0000       0.00000       2.2556+00    0.0000        0.0000        0.0000       1.018+01
      NMAT     US           VS           RHO          SIE          COMP          MASS         FRAC. VOL.     RHO(NVOID)=1.0  THETA= -1.00
        1    0.0000       0.0000       0.0000       0.0000       0.00000       0.0000        0.00000
        3    0.0000       0.0000       7.8000+00    0.0000       1.00000+00    2.2556+00     9.99995-01

  J   MFLAG    U            V            P            SIE          COMP          TMASS        SZZ           SRR           SRZ          Z

 34     0    0.0000       0.0000       0.0000       0.0000       0.00000       0.0000       0.0000        0.0000        0.0000       9.980+00
 33     0    0.0000       0.0000       0.0000       0.0000       0.00000       0.0000       0.0000        0.0000        0.0000       9.780+00
 32     0    0.0000       0.0000       0.0000       0.0000       0.00000       0.0000       0.0000        0.0000        0.0000       9.580+00
 31     0    0.0000       0.0000       0.0000       0.0000       0.00000       0.0000       0.0000        0.0000        0.0000       9.380+00
 30     0    0.0000       0.0000       0.0000       0.0000       0.00000       0.0000       0.0000        0.0000        0.0000       9.180+00
 29     0    0.0000       0.0000       0.0000       0.0000       0.00000       0.0000       0.0000        0.0000        0.0000       8.980+00
 28     0    0.0000       0.0000       0.0000       0.0000       0.00000       0.0000       0.0000        0.0000        0.0000       8.780+00
 27     0    0.0000       0.0000       0.0000       0.0000       0.00000       0.0000       0.0000        0.0000        0.0000       8.580+00
 26     0    0.0000       0.0000       0.0000       0.0000       0.00000       0.0000       0.0000        0.0000        0.0000       8.380+00
 25     0    0.0000       0.0000       0.0000       0.0000       0.00000       0.0000       0.0000        0.0000        0.0000       8.180+00
 24     0    0.0000       0.0000       0.0000       0.0000       0.00000       0.0000       0.0000        0.0000        0.0000       7.980+00
 23     0    0.0000       0.0000       0.0000       0.0000       0.00000       0.0000       0.0000        0.0000        0.0000       7.780+00
 22     0    0.0000       0.0000       0.0000       0.0000       0.00000       0.0000       0.0000        0.0000        0.0000       7.580+00
 21     0    0.0000       0.0000       0.0000       0.0000       0.00000       0.0000       0.0000        0.0000        0.0000       7.380+00
 20     0    0.0000       0.0000       0.0000       0.0000       0.00000       0.0000       0.0000        0.0000        0.0000       7.180+00
 19     0    0.0000       0.0000       0.0000       0.0000       0.00000       0.0000       0.0000        0.0000        0.0000       6.980+00
 18     0    0.0000       0.0000       0.0000       0.0000       0.00000       0.0000       0.0000        0.0000        0.0000       6.780+00
 17     0    0.0000       0.0000       0.0000       0.0000       0.00000       0.0000       0.0000        0.0000        0.0000       6.580+00
```

J	MFLAG	U	V	P	SIE	COMP	TMASS	SZZ	SRR	SRZ	Z
16	0	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.0000	0.0000	0.0000	[illegible]
15	0	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.0000	0.0000	0.0000	6.180+00
14	0	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.0000	0.0000	0.0000	5.960+00
13	0	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.0000	0.0000	0.0000	5.720+00
12	0	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.0000	0.0000	0.0000	5.450+00
11	0	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.0000	0.0000	0.0000	5.160+00
10	0	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.0000	0.0000	0.0000	4.840+00
9	0	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.0000	0.0000	0.0000	4.490+00
8	0	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.0000	0.0000	0.0000	4.100+00
7	0	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.0000	0.0000	0.0000	3.670+00
6	0	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.0000	0.0000	0.0000	3.200+00
5	0	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.0000	0.0000	0.0000	2.680+00
4	0	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.0000	0.0000	0.0000	2.110+00
3	0	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.0000	0.0000	0.0000	1.480+00
2	0	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.0000	0.0000	0.0000	8.400-01
1	0	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.0000	0.0000	0.0000	2.000-01

I = 7 R(I) = 1.3960+00 DR(I) = 2.4000000-01 TAU(I) = 1.9241626+00 T = 0.0000000 CYCLE = 0

J	MFLAG	U	V	P	SIE	COMP	TMASS	SZZ	SRR	SRZ	Z
37	2	0.0000	0.0000	0.0000	0.0000	1.00000+00	3.0017+00	0.0000	0.0000	0.0000	1.058+01
36	2	0.0000	0.0000	0.0000	0.0000	1.00000+00	3.0017+00	0.0000	0.0000	0.0000	1.038+01
35	147	0.0000	0.0000	0.0000	0.0000	0.00000	3.0017+00	0.0000	0.0000	0.0000	1.018+01

	NMAT	US	VS	RHO	SIE	COMP	MASS	FRAC. VOL.
	1	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.00000
	3	0.0000	0.0000	7.8000+00	0.0000	1.00000+00	3.0017+00	9.99995-01

RHO(NVOID)=1.0 THETA= -1.0[illegible]

J	MFLAG	U	V	P	SIE	COMP	TMASS	SZZ	SRR	SRZ	Z
34	0	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.0000	0.0000	0.0000	9.980+01
33	0	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.0000	0.0000	0.0000	[illegible]
32	0	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.0000	0.0000	0.0000	9.580+01
31	0	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.0000	0.0000	0.0000	9.380+01
30	0	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.0000	0.0000	0.0000	9.180+01
29	0	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.0000	0.0000	0.0000	8.980+0
28	0	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.0000	0.0000	0.0000	8.780+0
27	0	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.0000	0.0000	0.0000	8.580+0
26	0	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.0000	0.0000	0.0000	8.380+0
25	0	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.0000	0.0000	0.0000	8.180+0
24	0	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.0000	0.0000	0.0000	7.980+0
23	0	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.0000	0.0000	0.0000	7.780+0
22	0	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.0000	0.0000	0.0000	7.580+0
21	0	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.0000	0.0000	0.0000	7.380+0
20	0	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.0000	0.0000	0.0000	7.180+0
19	0	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.0000	0.0000	0.0000	6.980+0
18	0	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.0000	0.0000	0.0000	6.780+0
17	0	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.0000	0.0000	0.0000	6.580+0
16	0	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.0000	0.0000	0.0000	6.380+0
15	0	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.0000	0.0000	0.0000	6.180+0
14	0	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.0000	0.0000	0.0000	5.960+0
13	0	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.0000	0.0000	0.0000	5.720+0
12	0	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.0000	0.0000	0.0000	5.450+0

11	0	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.0000	0.0000	0.0000	5.160+00
10	0	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.0000	0.0000	0.0000	4.840+00
9	0	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.0000	0.0000	0.0000	4.490+00
8	0	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.0000	0.0000	0.0000	4.100+00
7	0	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.0000	0.0000	0.0000	3.670+00
6	0	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.0000	0.0000	0.0000	3.200+00
5	0	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.0000	0.0000	0.0000	2.680+00
4	0	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.0000	0.0000	0.0000	2.110+00
3	0	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.0000	0.0000	0.0000	1.480+00
2	0	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.0000	0.0000	0.0000	8.400-01
1	0	0.0000	0.0000	0.0000	0.0000	0.00000	0.0000	0.0000	0.0000	0.0000	2.000-01

SPHASE ETH= 4.22361330+11 ESUM= 4.22361305+11 EMIX= 4.22361305+11 RELERR= -5.81871449-08
HPHASE ETH= 4.22361330+11 ESUM= 4.22361305+11 EMIX= 4.22361305+11 RELERR= -5.81871449-08

DISPLAY OF MIXED AND PURE CELLS   M = MIXED CELL   NUMERAL N = PURE CELL OF PACKAGE N MATERIAL

```
    I
    I
 60 I M M M M M M M M M M M M M M M M M M M M M M M M M M M M M
    I 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 M
    I 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 M
    I 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 M
    I 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 M
 55 I 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 M
    I 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 M
    I 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 M
    I 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 M
    I 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 M
 50 I 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 M
    I 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 M
    I 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 M
    I 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 M
    I 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 M
 45 I 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 M
    I 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 M
    I 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 M
    I 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 M
    I 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 M
 40 I 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 M
    I 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 M
    I 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 M
    I 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 M
    I 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 M
 35 I M M M M M M M M M M M M M M M M M M M M M M M M M M M M M
    I 1 M
    I 1 M
    I 1 M M
    I 1 1 M
 30 I 1 1 M
    I 1 1 M
    I 1 1 M
    I 1 1 M M
    I 1 1 1 M
 25 I 1 1 1 M
    I 1 1 1 M
    I 1 1 1 M
    I 1 1 1 M M
    I 1 1 1 1 M
 20 I 1 1 1 1 M
    I 1 1 1 1 M
    I 1 1 1 1 M
    I 1 1 1 1 M
    I 1 1 1 1 M
 15 I 1 1 1 1 M
    I 1 1 1 1 M
    I 1 1 1 1 M
    I 1 1 1 1 M
```

```
           I I I I I M
        10 I I I I I M
           I I I I I M
           I I I I I M
           I I I I I M
           I I I I I M
         5 I I I I I M
           I I I I I M
           I I I I I M
           I M M M M M
           I
         0 I + + + + + + + + + + + + + + + + + + + + + + + + + + + + + + +
           0         5         10        15        20        25        30
TPHASE   ETH=     4.22361326+11     ESUM=    4.22361108+11     EMIX=    4.22361108+11     RELERR=   -5.13986450407
CYCLE     1

CDT  4   21  T= 8.0701754-10  DT= 1.6140351-09  MAXCUV= 4.5600000+05  MAXUV= 5.5000000+04  UMIN= 4.5599999+00  PMIN= 5.0000000+06
SPHASE   ETH=     4.22361326+11     ESUM=    4.22361108+11     EMIX=    4.22361108+11     RELERR=   -5.13986450-07
HPHASE   ETH=     4.22361326+11     ESUM=    4.22361113+11     EMIX=    4.22361108+11     RELERR=   -5.13986450-07
TPHASE   ETH=     4.22361321+11     ESUM=    4.22361104+11     EMIX=    4.22361100+11     RELERR=   -5.23684314-07
CYCLE     2

CDT  1   34  T= 2.4210526-09  DT= 3.1381382-09  MAXCUV= 4.6906793+05  MAXUV= 5.4999999+04  UMIN= 4.6906793+00  PMIN= 5.0000000+06
SPHASE   ETH=     4.22361321+11     ESUM=    4.22361104+11     EMIX=    4.22361100+11     RELERR=   -5.23684314-07
HPHASE   ETH=     4.22361321+11     ESUM=    4.22361108+11     EMIX=    4.22361100+11     RELERR=   -5.23684314-07
TPHASE   ETH=     4.22361321+11     ESUM=    4.22361096+11     EMIX=    4.22361096+11     RELERR=   -5.33382170-07
CYCLE     3

CDT  1   34  T= 5.5591908-09  DT= 6.1535677-09  MAXCUV= 4.7842164+05  MAXUV= 5.4999999+04  UMIN= 4.7842164+00  PMIN= 5.0000000+06
SPHASE   ETH=     4.22361321+11     ESUM=    4.22361092+11     EMIX=    4.22361088+11     RELERR=   -5.52777884407
HPHASE   ETH=     4.22361321+11     ESUM=    4.22361100+11     EMIX=    4.22361092+11     RELERR=   -5.43080027-07
TPHASE   ETH=     4.22361317+11     ESUM=    4.22361100+11     EMIX=    4.22361100+11     RELERR=   -5.13986457-07
CYCLE     4

CDT  1   34  T= 1.1712759-08  DT= 1.2017347-08  MAXCUV= 4.8995840+05  MAXUV= 5.4999998+04  UMIN= 4.8995840+00  PMIN= 5.0000000+06
SPHASE   ETH=     4.22361317+11     ESUM=    4.22361100+11     EMIX=    4.22361096+11     RELERR=   -5.23684321-07
HPHASE   ETH=     4.22361317+11     ESUM=    4.22361096+11     EMIX=    4.22361092+11     RELERR=   -5.33382178-07
TPHASE   ETH=     4.22361309+11     ESUM=    4.22361084+11     EMIX=    4.22361092+11     RELERR=   -5.13986471-07
CYCLE     5

CDT  1   34  T= 2.3730105-08  DT= 2.3309503-08  MAXCUV= 5.0520167+05  MAXUV= 5.4999998+04  UMIN= 5.0520166+00  PMIN= 5.0000000+06
SPHASE   ETH=     4.22361309+11     ESUM=    4.22361080+11     EMIX=    4.22361088+11     RELERR=   -5.23684328-07
HPHASE   ETH=     4.22361309+11     ESUM=    4.22361084+11     EMIX=    4.22361080+11     RELERR=   -5.43080041-07
TPHASE   ETH=     4.22361293+11     ESUM=    4.22361059+11     EMIX=    4.22361063+11     RELERR=   -5.43080063-07
CYCLE     6

CDT  1   34  T= 4.7039609-08  DT= 4.4797315-08  MAXCUV= 5.2574579+05  MAXUV= 5.4999997+04  UMIN= 5.2574579+00  PMIN= 5.0000000+06
SPHASE   ETH=     4.22361293+11     ESUM=    4.22361055+11     EMIX=    4.22361059+11     RELERR=   -5.52777927-07
HPHASE   ETH=     4.22361293+11     ESUM=    4.22361059+11     EMIX=    4.22361055+11     RELERR=   -5.62475783-07
TPHASE   ETH=     4.22361264+11     ESUM=    4.22361018+11     EMIX=    4.22361022+11     RELERR=   -5.72173683-07
CYCLE     7

CDT  1   34  T= 9.1836924-08  DT= 8.5163035-08  MAXCUV= 5.5310382+05  MAXUV= 5.4999997+04  UMIN= 5.5310382+00  PMIN= 5.0000000+06
SPHASE   ETH=     4.22361264+11     ESUM=    4.22361018+11     EMIX=    4.22361018+11     RELERR=   -5.81871539-07
```

CHAPTER XII

REPRESENTATIVE APPLICATIONS OF THE HELP CODE

Over the past several years the HELP code has been applied to a wide variety of physical problems in the areas of fluid and solid mechanics. These applications, which have involved a large variety of materials with a wide range of material properties and initial conditions, include studies in hypervelocity and ballistic impact, high explosive-metal systems, shaped charge jet formation and penetration, and energy deposition and stress wave propagation. In this section selected results from these various applications are presented. References are provided for those interested in further details of the various investigations.

12.1 HYPERVELOCITY IMPACT

The selected hypervelocity impact results shown here were taken from a numerical parameter study [13] in which material properties were varied in order to assess the effects of those properties on cratering and mass loss.

Figures 12.1 and 12.2 show the predicted projectile/ target configuration at various times for spheres of equal masses of ice and water impacting normally into an aluminum target at a velocity of 3.05×10^5 cm/sec.

It is seen from Figure 12.3 that there is no significant difference in the predicted crater depths for the two impacts involving ice and water projectiles. The fact that the maxima in the crater depth curves do not occur at the latest times is a result of crater relaxation which is typical in soft aluminum targets. Figure 12.4 is a comparison of the predicted final crater shape (solid line) for the ice-aluminum impact with the measured profile (dashed lines) obtained from experimental data provided by Mr. William Gray at Martin Marietta in Orlando. As is seen in Figure 12.4, agreement between theory and experiment is quite good. The shaded region in the vicinity of the crater lip (Figure 12.4) shows the predicted crater ejecta which has been removed for comparison with experiment in Figure 12.4.

The results of a calculation involving a spherical glass projectile impacting 6061-T6 aluminum at 3.05×10^5 cm/sec was also compared with experimental data provided by Martin Marietta. Figure 12.5 compares the calculated (solid line) and experimentally measured (dashed line) final crater profiles. The experimental crater was not exactly axisymmetric so profiles taken at two different cross sections are shown in the figure. Both the predicted crater

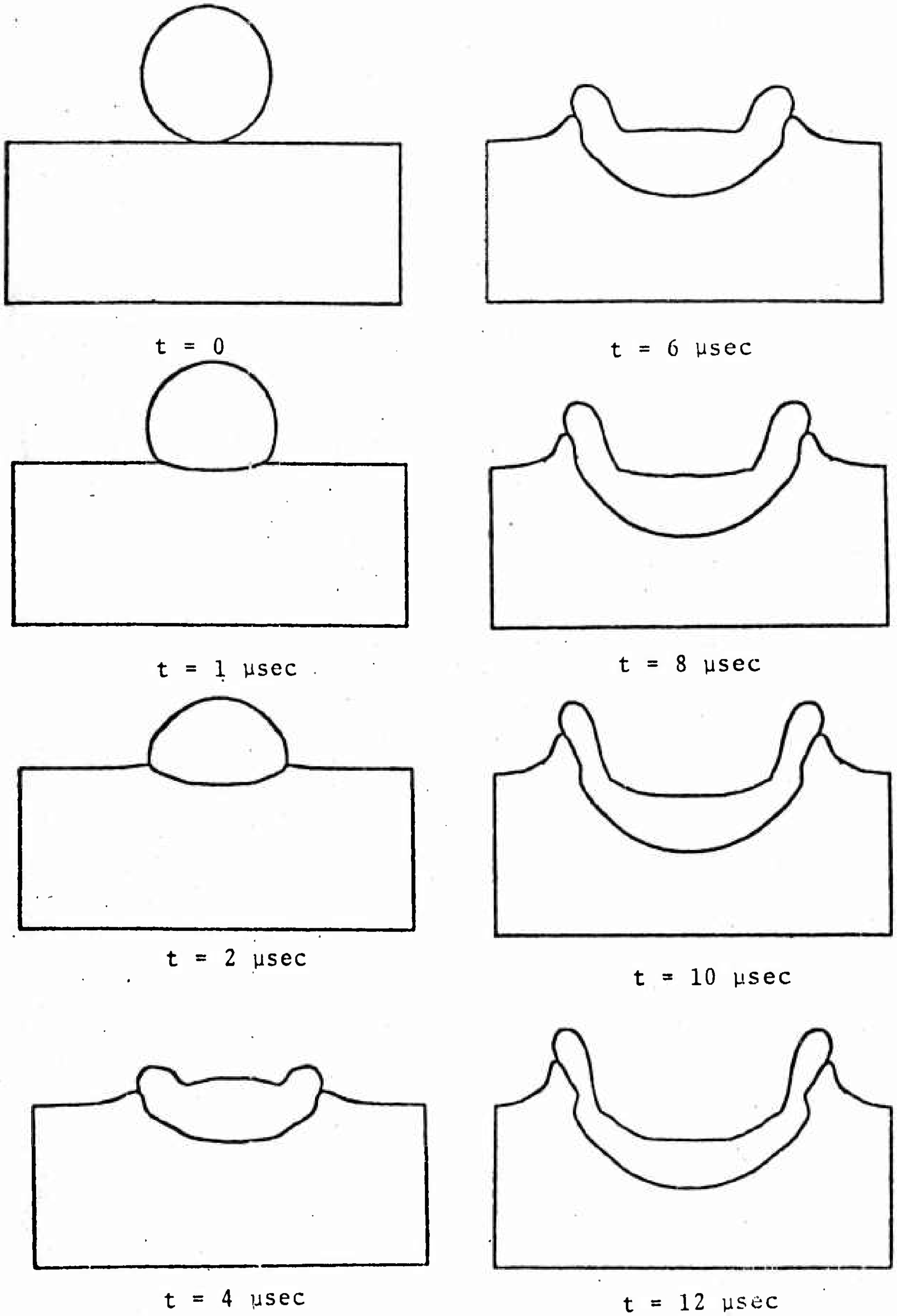


Figure 12.1--Projectile-target configurations at various times for the Ice/Al impact at 3.05×10^5 cm/sec.

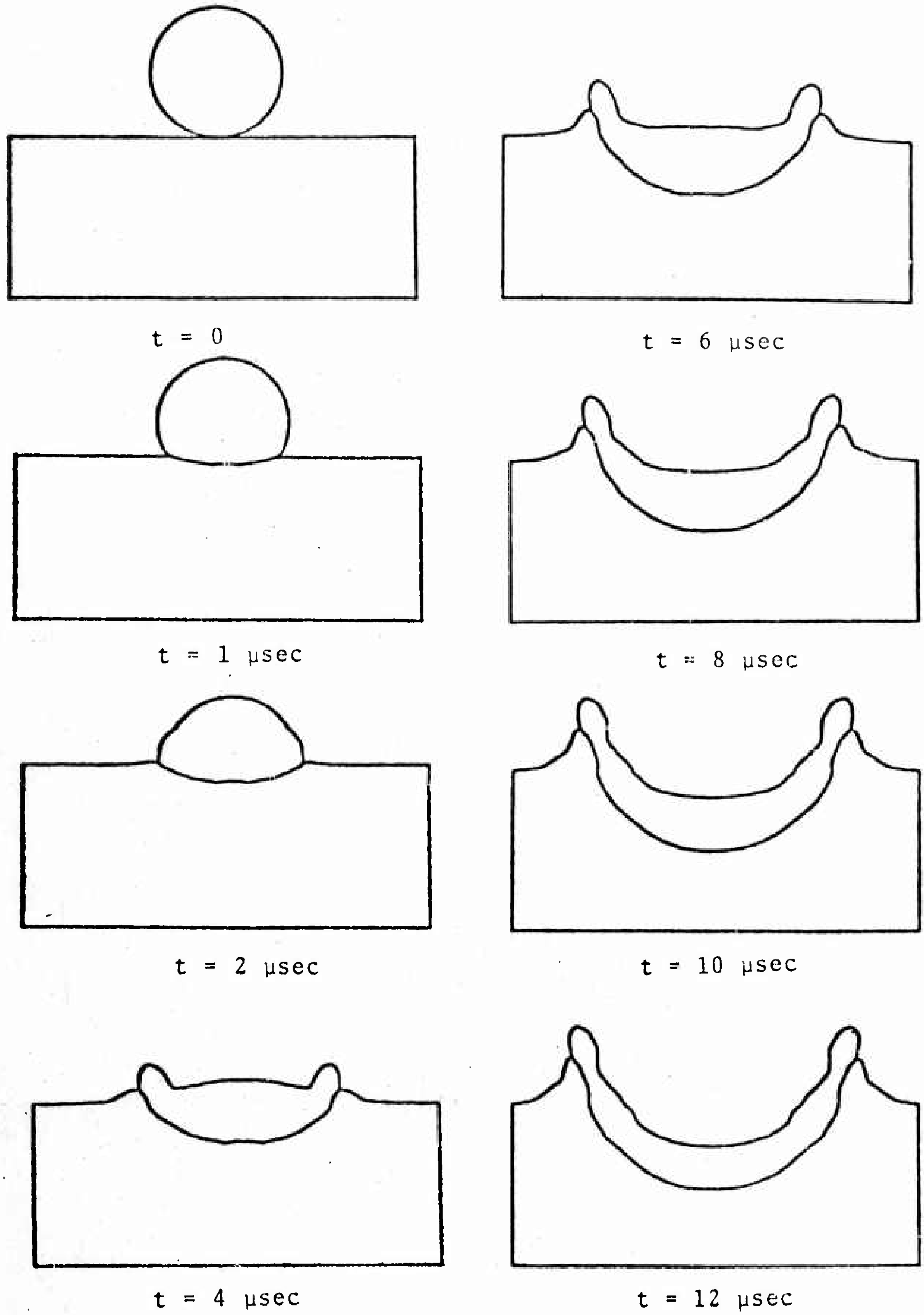


Figure 12.2--Projectile-target configurations at various times for the Water/Al impact at 3.05×10^5 cm/sec.

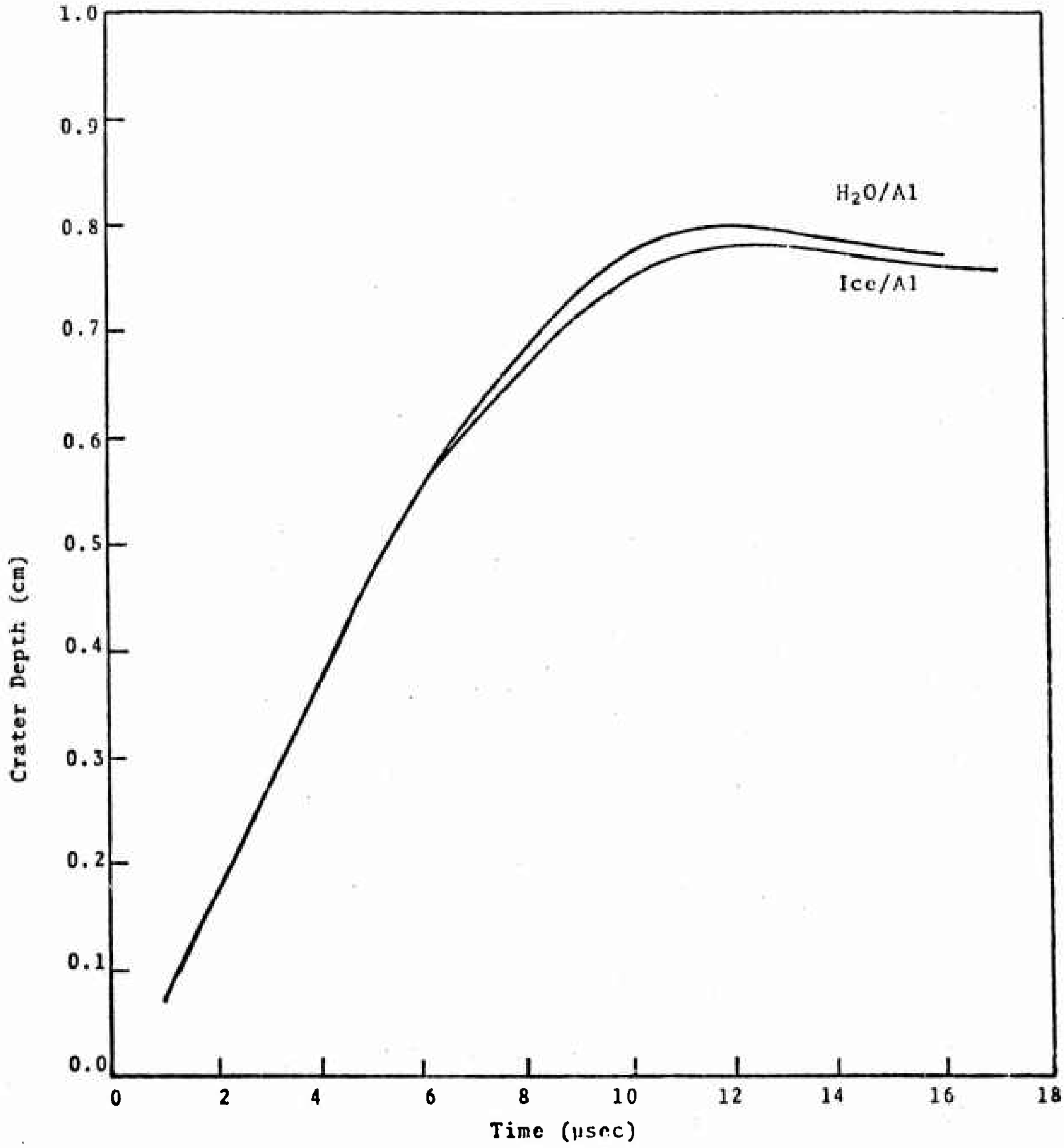
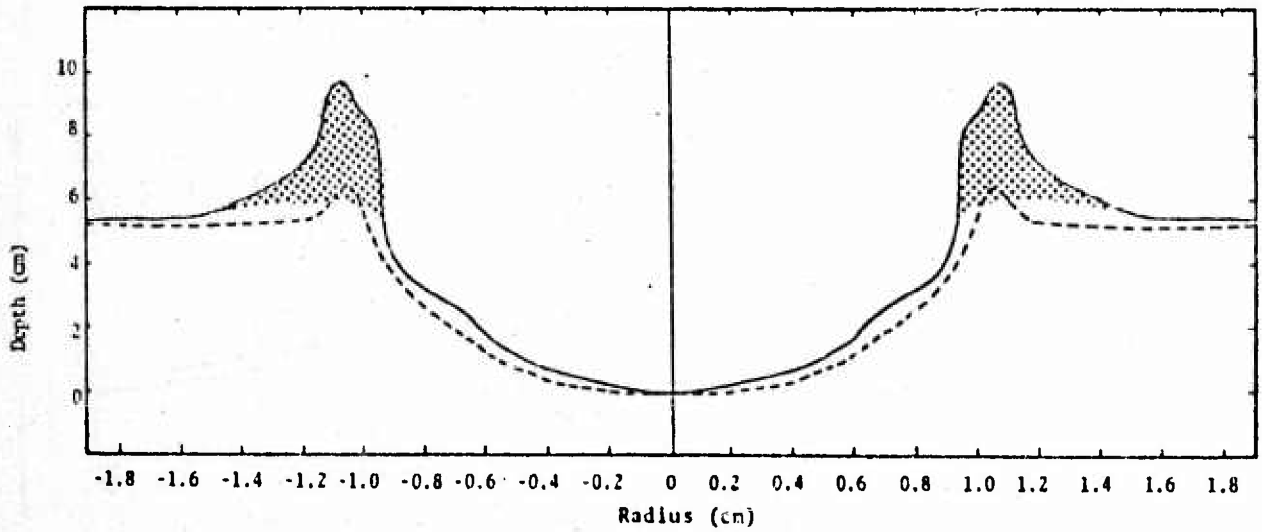
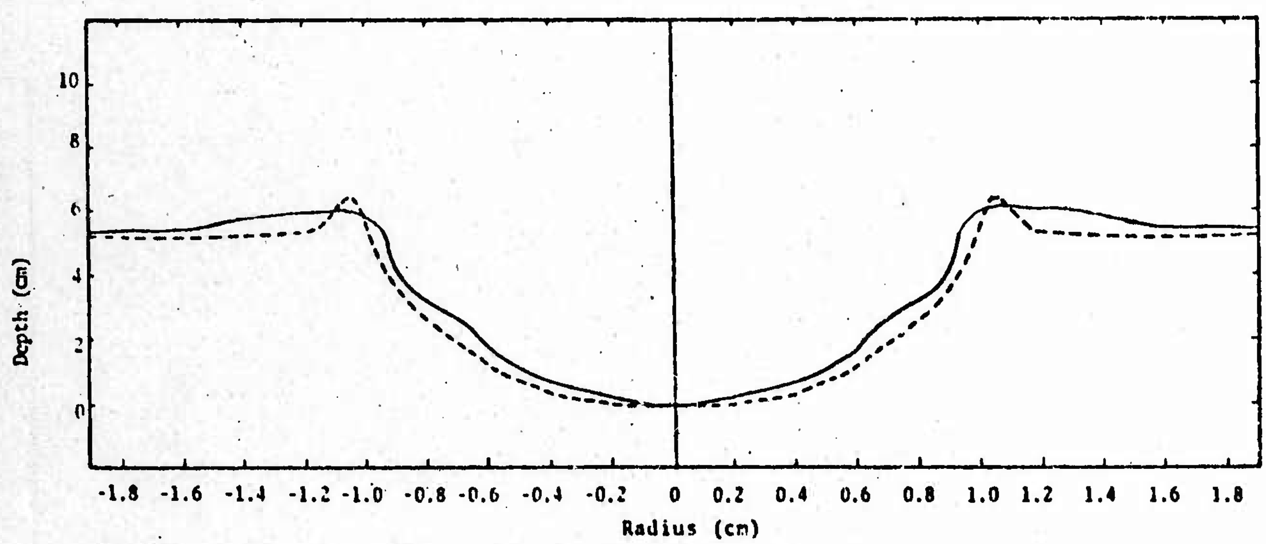


Figure 12.3--Predicted crater depth versus time for the calculations of Figures 12.1 and 12.2.

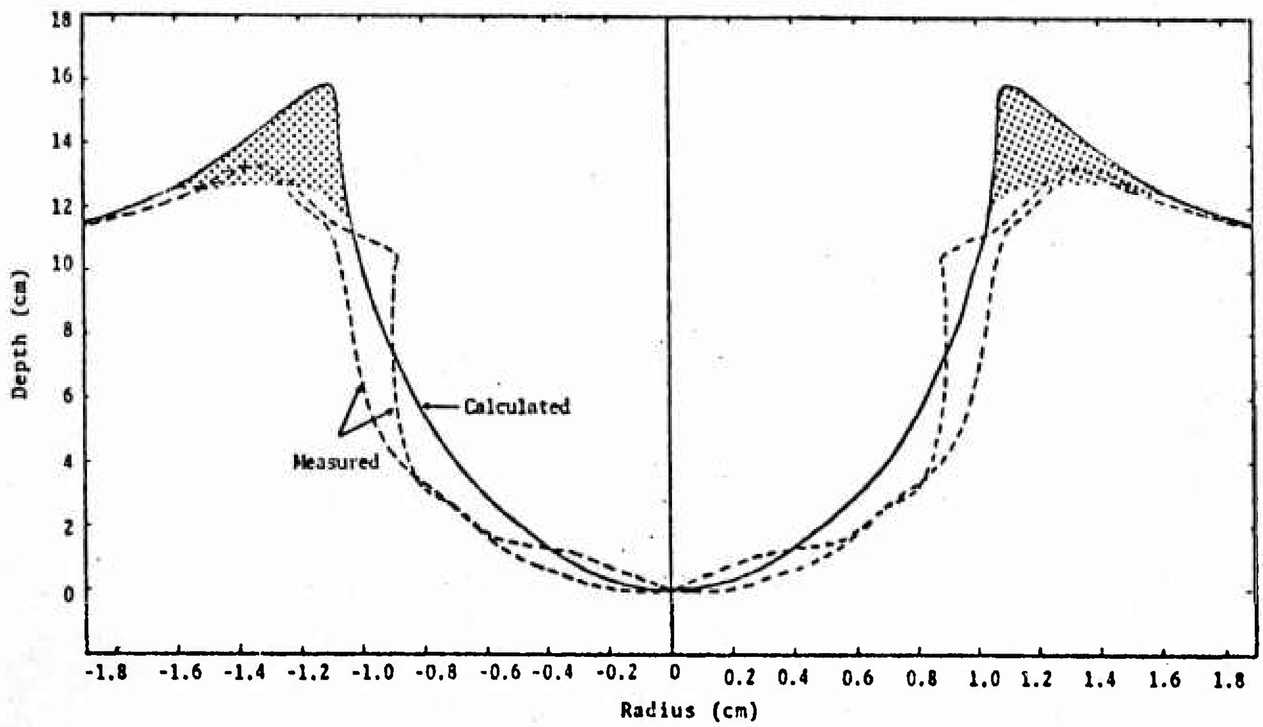


a) Shaded region indicates the predicted crater ejecta.

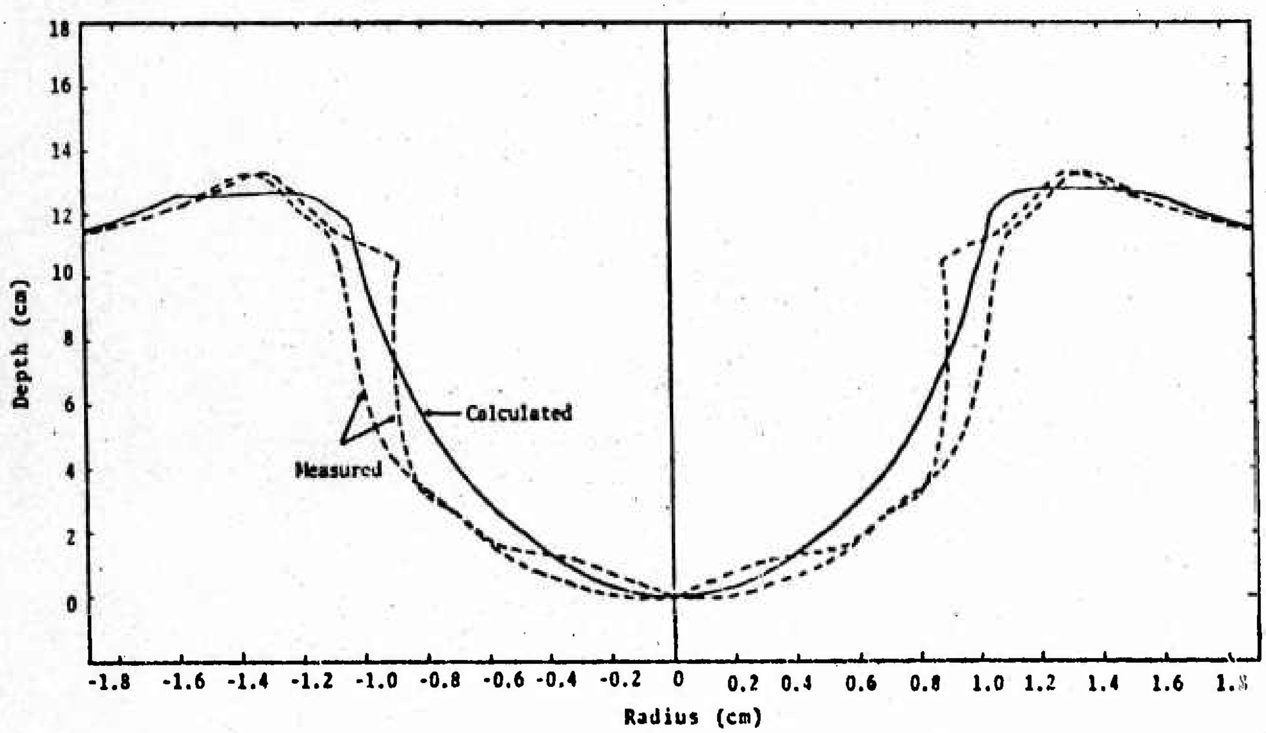


b) Final predicted crater with ejecta removed.

Figure 12.4--Comparison of the calculated and measured craters for an ice sphere impacting aluminum at 3.05×10^5 cm/sec.



a) Shaded region indicates the predicted crater ejecta.

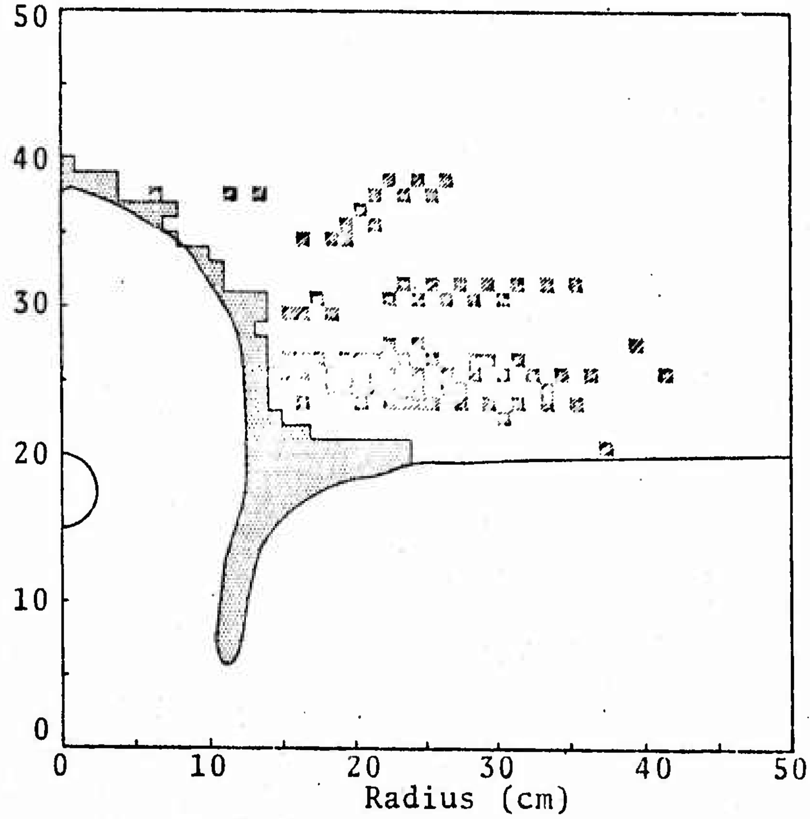


b) Final predicted crater with ejecta removed.

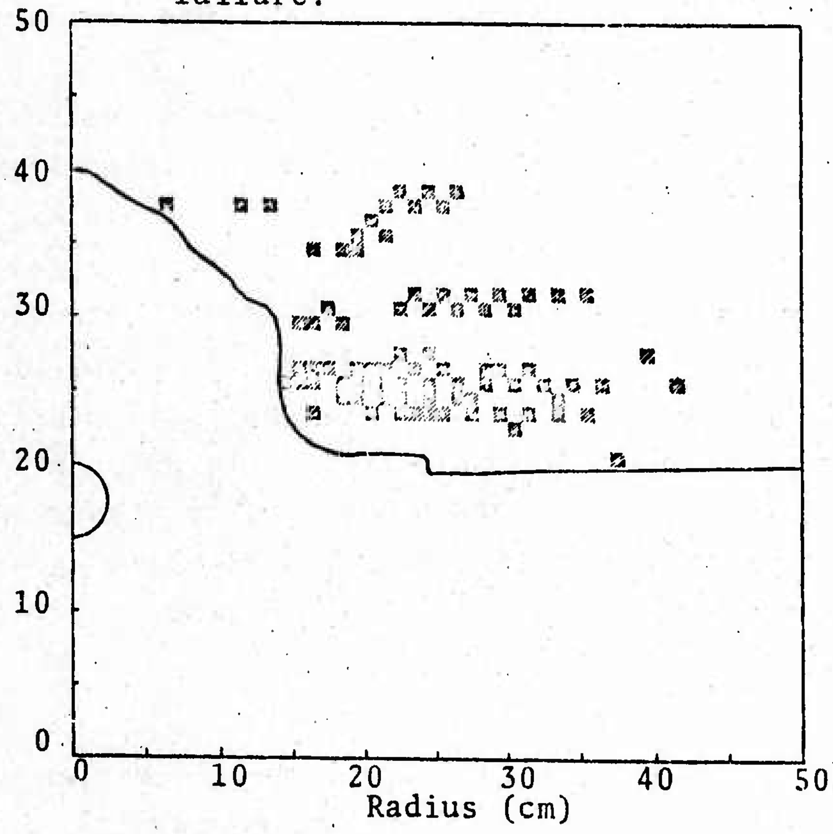
Figure 12.5--Comparison of the calculated and measured craters for a 0.953 cm diameter glass sphere impacting aluminum at 3.05×10^5 cm/sec.

depth and crater diameter are in good agreement with experiment. Again, the shaded region (Figure 12.5a) has been removed in Figure 12.5b since it represents failed material.

Figure 12.6 shows the predicted final configurations for the calculation of a glass bead into ATJ-S graphite at 6.1×10^5 cm/sec. The shaded regions represent material failure. In addition to the failure predicted in the vicinity of the crater and the lip, several radial bands of failed material are in evidence. This type of failure seems to be typical of ATJ-S graphite when impacted by particles in the hypervelocity regime.



a) Shaded region indicates predicted material failure.



b) Final predicted crater with failed material removed.

Figure 12.6--The predicted final target configuration for the calculation of glass into ATJ-S graphite at 6.1×10^5 cm/sec. The shaded cells indicate regions of material failure. The initial position and size of the glass bead is also indicated.

12.2 PLUGGING FAILURE

When a blunt projectile impacts a relatively thin target, a plug of target material is sheared out ahead of the projectile. Plugging failure is modeled in HELP by allowing a slip surface to progress through the target in the direction of the maximum shear stress when the material ahead of the advancing slipline is subjected to conditions such that the plastic work exceeds a critical value. (See Chapter VI.) The results presented in this subsection were selected from several recent numerical investigations of plugging failure [14-17].

Figure 12.7 is a series of computer output plots showing the predicted steel projectile and aluminum target configuration for an impact calculation at various times after impact. The initial impact velocity was 5.56×10^4 cm/sec. Figure 12.8 is a similar plot for a calculation in which the impact velocity was 2.36×10^4 cm/sec. Both calculations were carried out in time until the kinetic energy of the projectile approached its asymptotic value. Several differences in the computed results can be noted by comparing Figures 12.7 and 12.8. The plug forms much sooner in the higher velocity impact situation ($V_o = 5.56 \times 10^4$ cm/sec) of Figure 12.7 than in the lower velocity impact situation ($V_o = 2.36 \times 10^4$ cm/sec) of Figure 12.8. As might be expected, Figure 12.7 indicates that the projectile deforms considerably whereas very little projectile deformation is evident in Figure 12.8. Another numerically predicted velocity-related trend in the calculations which agrees with observation and is in evidence in Figures 12.7 and 12.8 involves the decrease in plug taper angle as the impact velocity decreases.

Figure 12.9 shows the calculated plug formation and subsequent deformation resulting from the impact of a steel

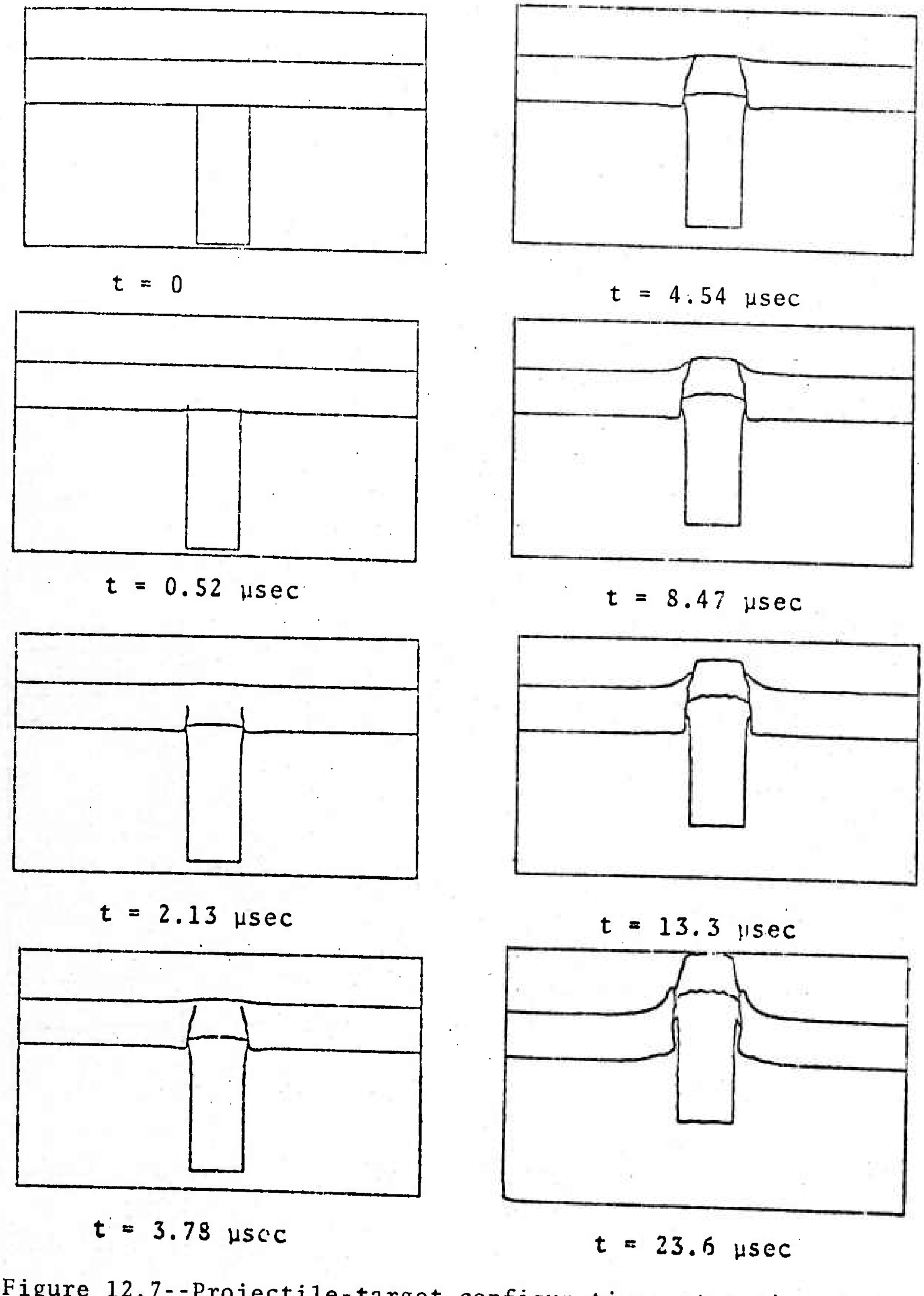


Figure 12.7--Projectile-target configurations at various times for the calculation of a steel cylinder impacting an aluminum target at a velocity of 5.56×10^4 cm/sec.

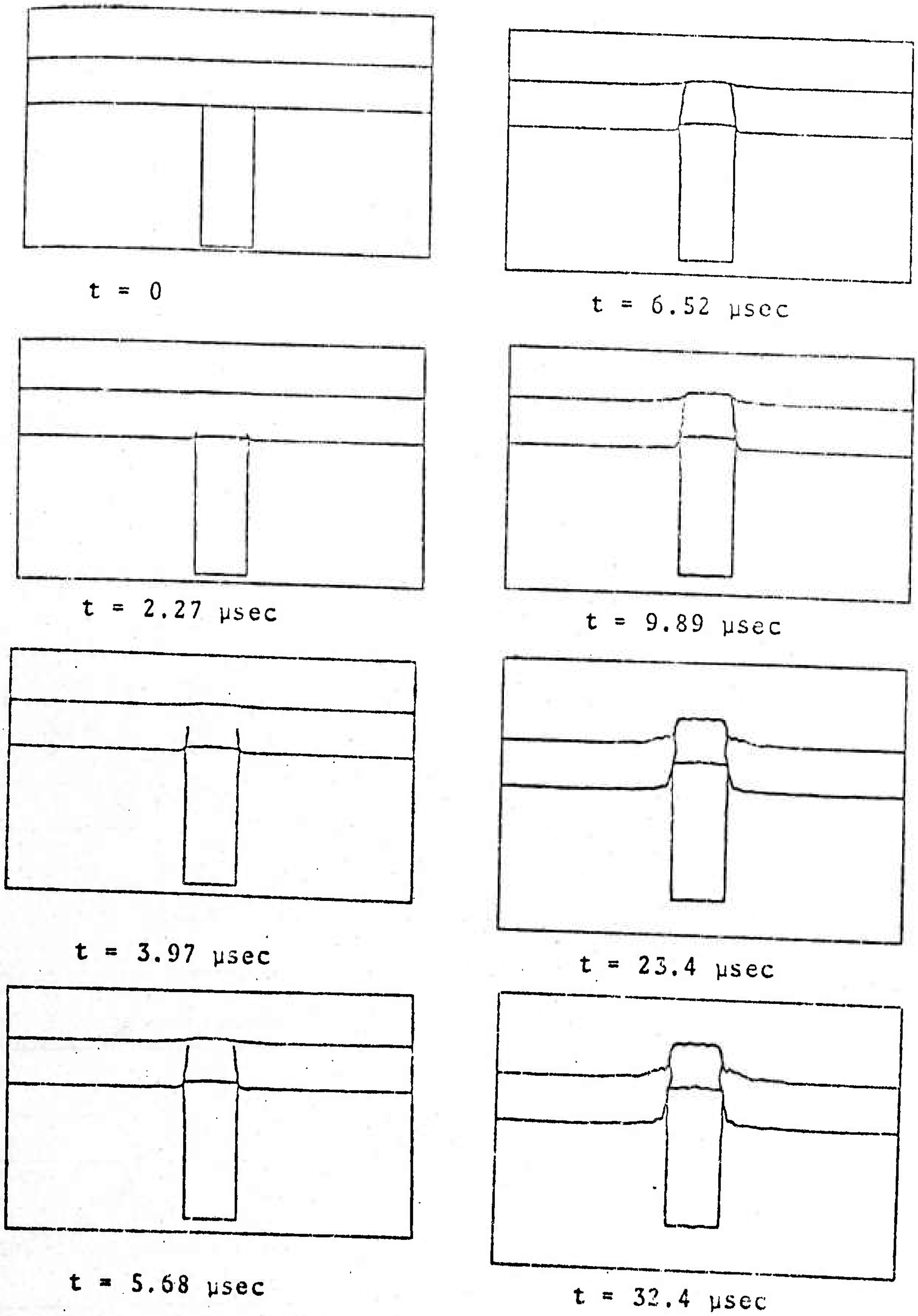


Figure 12.8--Projectile-target configurations at various times for the calculation of a steel cylinder impacting an aluminum target at a velocity of 2.36×10^4 cm/sec.

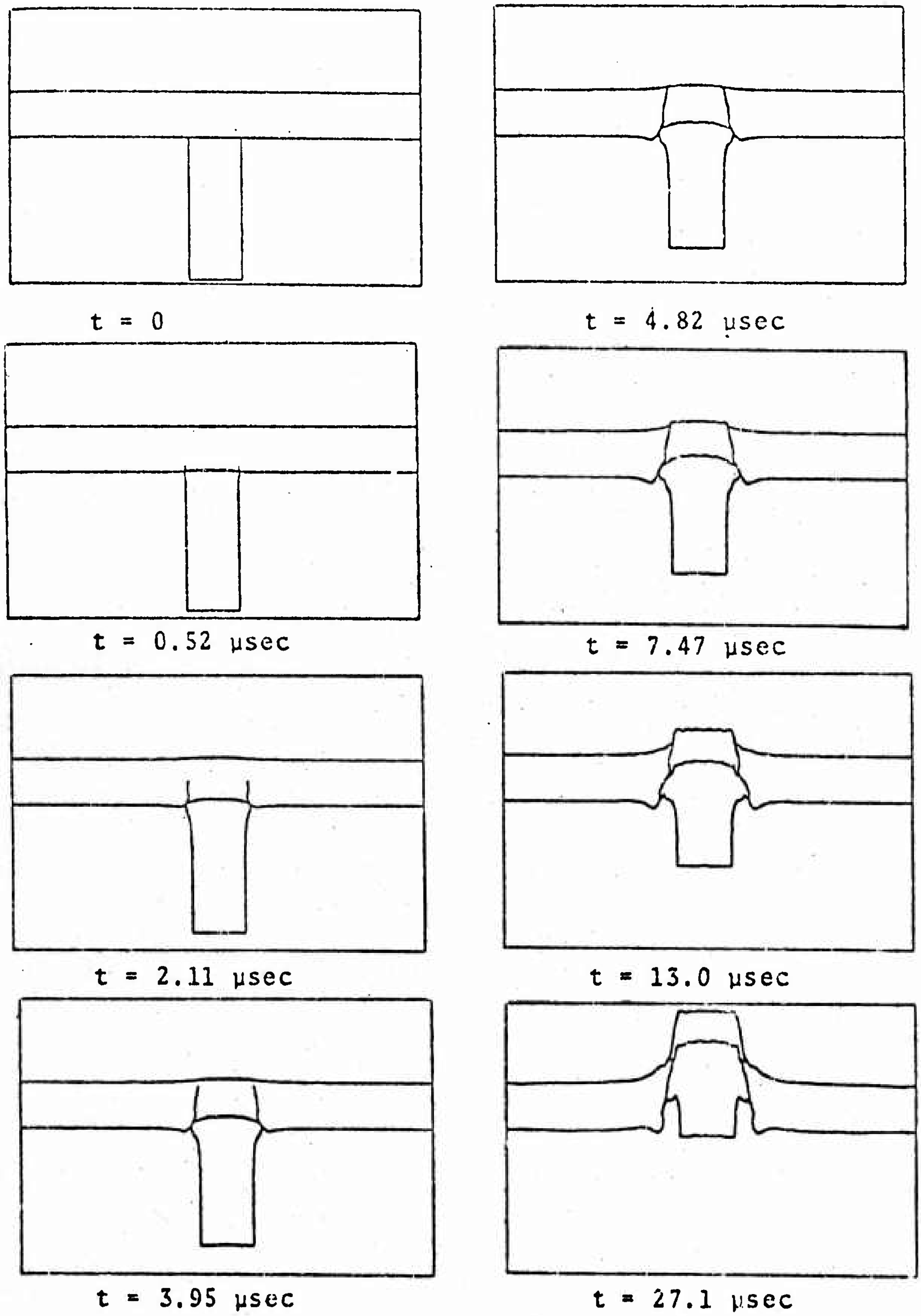


Figure 12.9--Projectile-target configurations at various times for the calculation of a steel cylinder impacting a steel target at a velocity of 8.81×10^4 cm/sec.

cylinder into a steel target at a velocity of 8.81×10^4 cm/sec. The effect of the increased target density and yield strength is clearly evident by noting the extensive projectile deformation.

A plot of residual projectile velocity versus impact velocity is shown in Figure 12.10. The predicted values from these calculations (solid circles) are compared with experimental data (open circles) provided by Eglin Air Force Base [16]. The agreement between the numerical predictions and experiment is quite good.

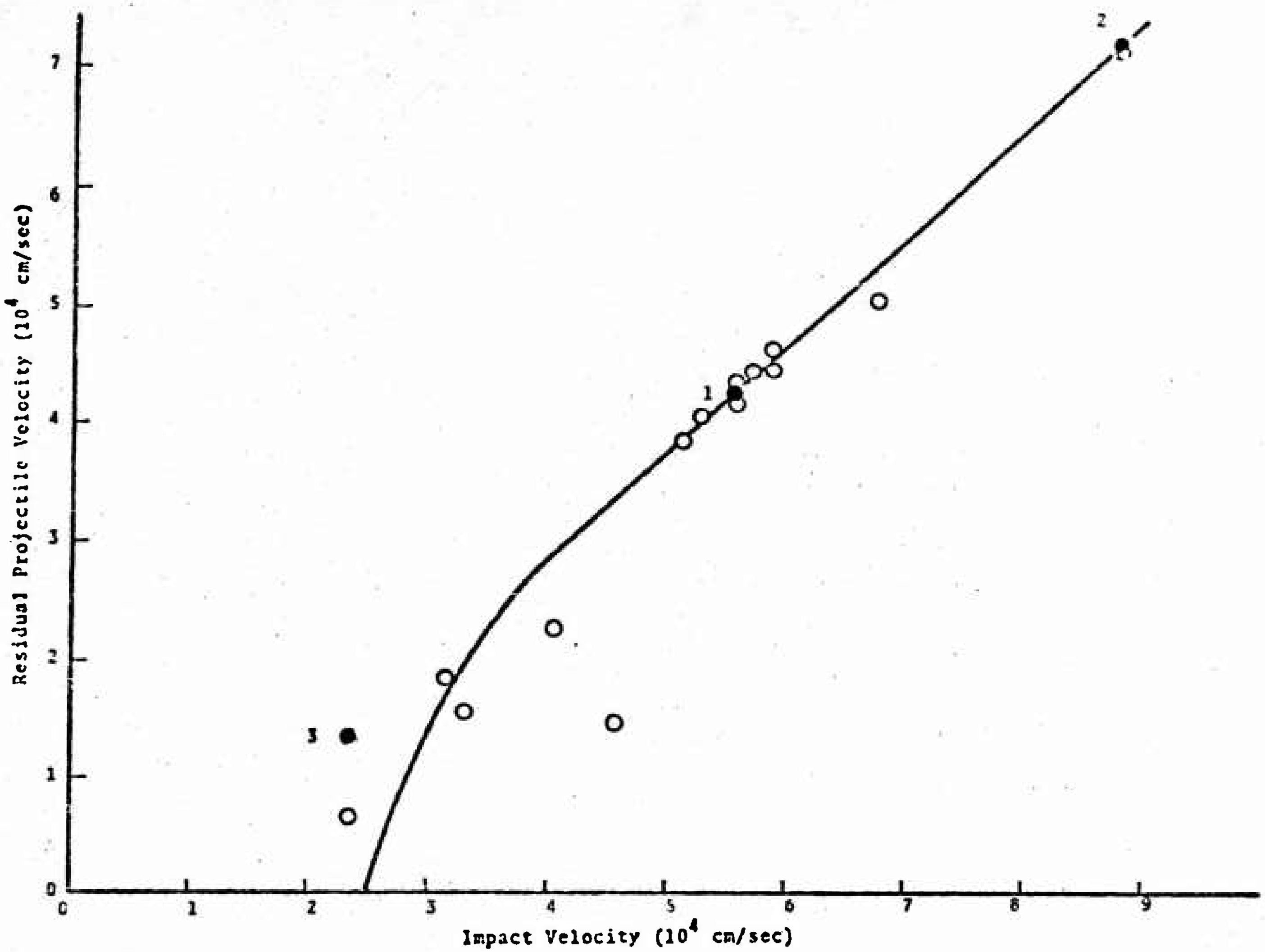


Figure 12.10--Residual projectile velocity versus impact velocity for the steel cylinders impacting aluminum targets. The solid circles represent computed values, and the open circles represent experimentally observed values.

12.3 LONG ROD PENETRATION AT OBLIQUE INCIDENCE

The plane strain option in HELP was employed to approximate a series of long rod oblique impacts. It is important to keep in mind, when analyzing the results from such a series of calculations, that the real three dimensional case is not being solved. For example, no strain is allowed in the direction perpendicular to the plane of impact (plane formed by initial impact velocity vector and target normal). In addition the mass of the projectile is based on the volume obtained by translating the central cross section of the projectile one unit length perpendicular to the plane of impact. However, many things can be learned from the plane strain approximation to oblique impact. In a recent parameter study [18] it was of interest to rank several different projectile designs according to the extent of nose tip failure and projectile bending. It was felt that these rankings could be accomplished by comparing results from a series of 2-D, plane-strain calculations. In the sample calculation presented here, a steel-jacketed, tungsten alloy penetrator is impacted at 60^o obliquity against a thin steel target at a velocity of 1.53×10^5 cm/sec. The projectile-target configurations at various times for this impact solution are shown in Figure 12.11.

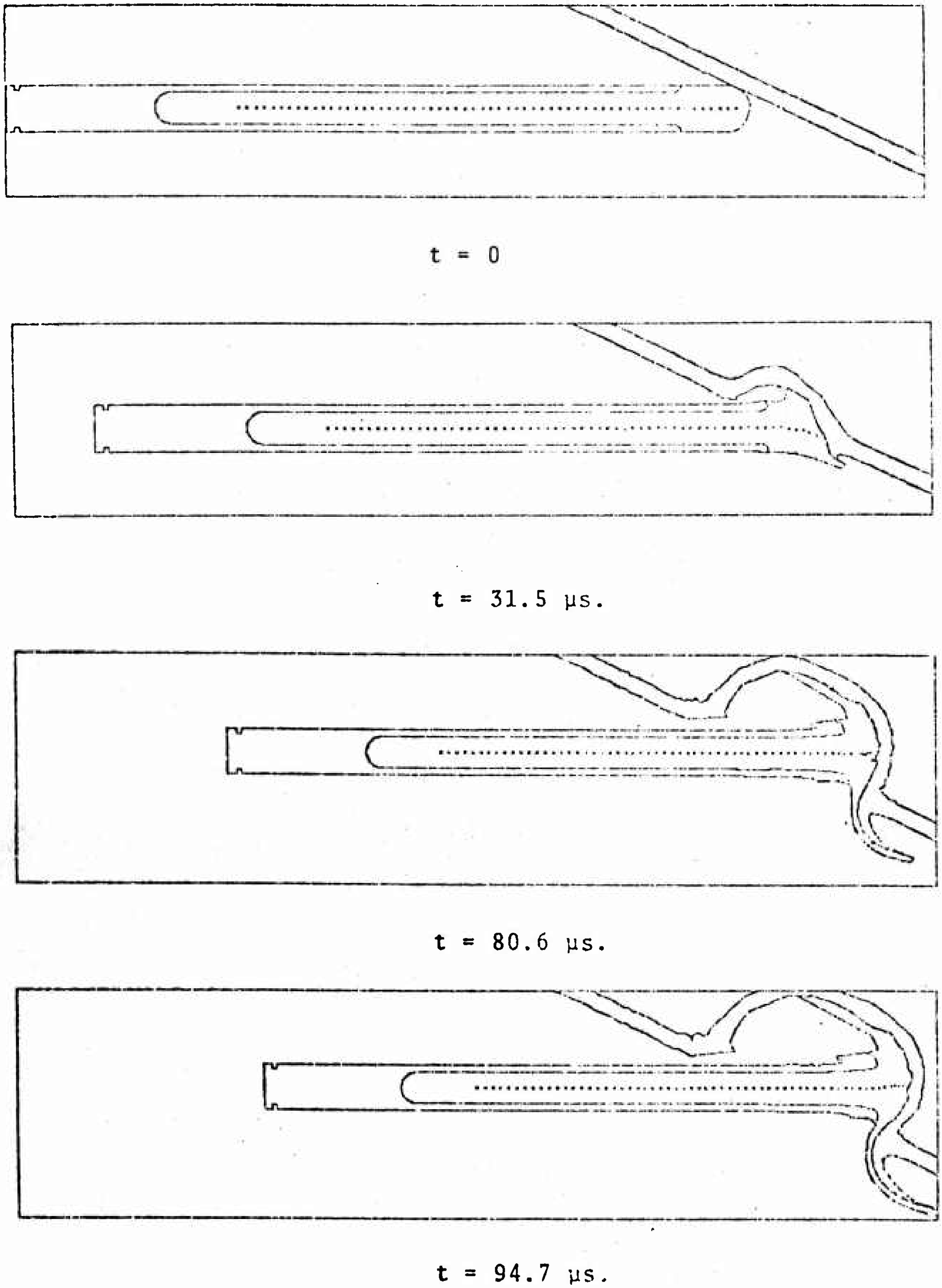


Figure 12.11--Two-dimensional plane strain approximation to an oblique impact.

12.4 MULTIPLE IMPACT

The HELP code was employed in an exploratory investigation of the effect of projectile geometry on back surface spall [19]. The initial configurations of the two impact situations of interest are shown in Figure 12.12. The solid projectile is a steel cylinder with a hemispherical nose. The spaced pellet projectile is composed of four steel pellets having a total mass (3g), equal to the mass of the solid projectile. Both projectiles were impacted into a 1-cm-thick steel plate at a velocity of 9.15×10^4 cm/sec. In order to compute the impact of spaced pellets the basic HELP code was modified so that voids between the pellets could be removed as the pellets impacted one another.

While it was of primary interest to compare the two projectile designs in terms of their ability to create stress conditions suitable for back surface spall, it was also of interest to compare the penetrability of the two projectiles. Figures 12.13 and 12.14 are computer plots of the projectile-target configurations at various times after impact for the solid and spaced pellet projectiles, respectively. The crater at 10 μsec in Figure 12.13 should be compared with the crater at 12 μsec in Figure 12.14 since the percent reduction in kinetic energy for the two projectiles is equal at those times. This time lag in projectile kinetic energy reduction is a result of the spacing in the spaced-pellet projectile. It can be concluded that the penetrability of the two projectile designs are equivalent for the impact situations considered here. Situations could exist, however, for which multiple impact might enhance the crater size. Such enhancement would be a function of relative dimensions and pellet spacing.

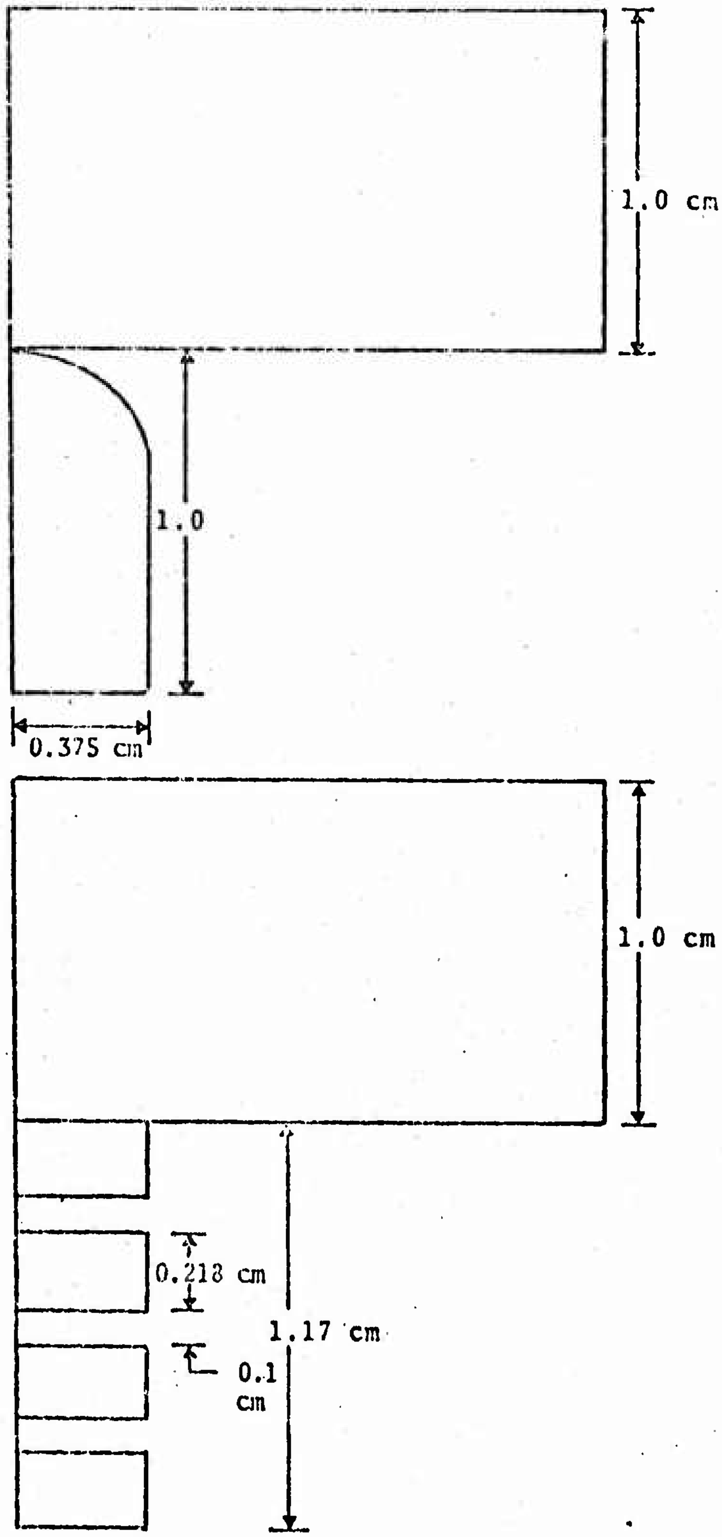


Figure 12.12--Initial configurations for the solid and spaced pellet projectile impact situations.

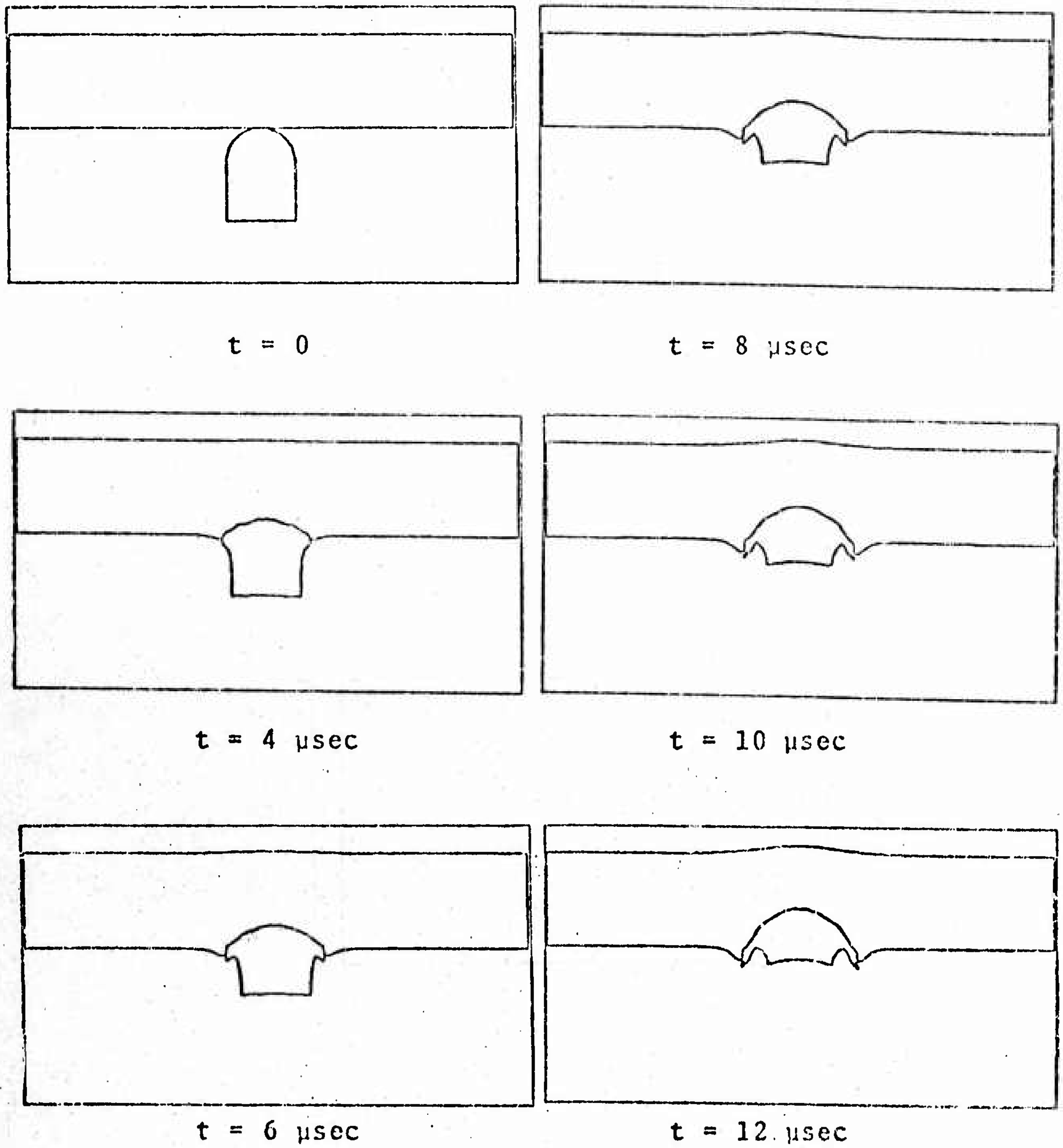


Figure 12.13--Projectile-target configurations at various times for the solid projectile impact.

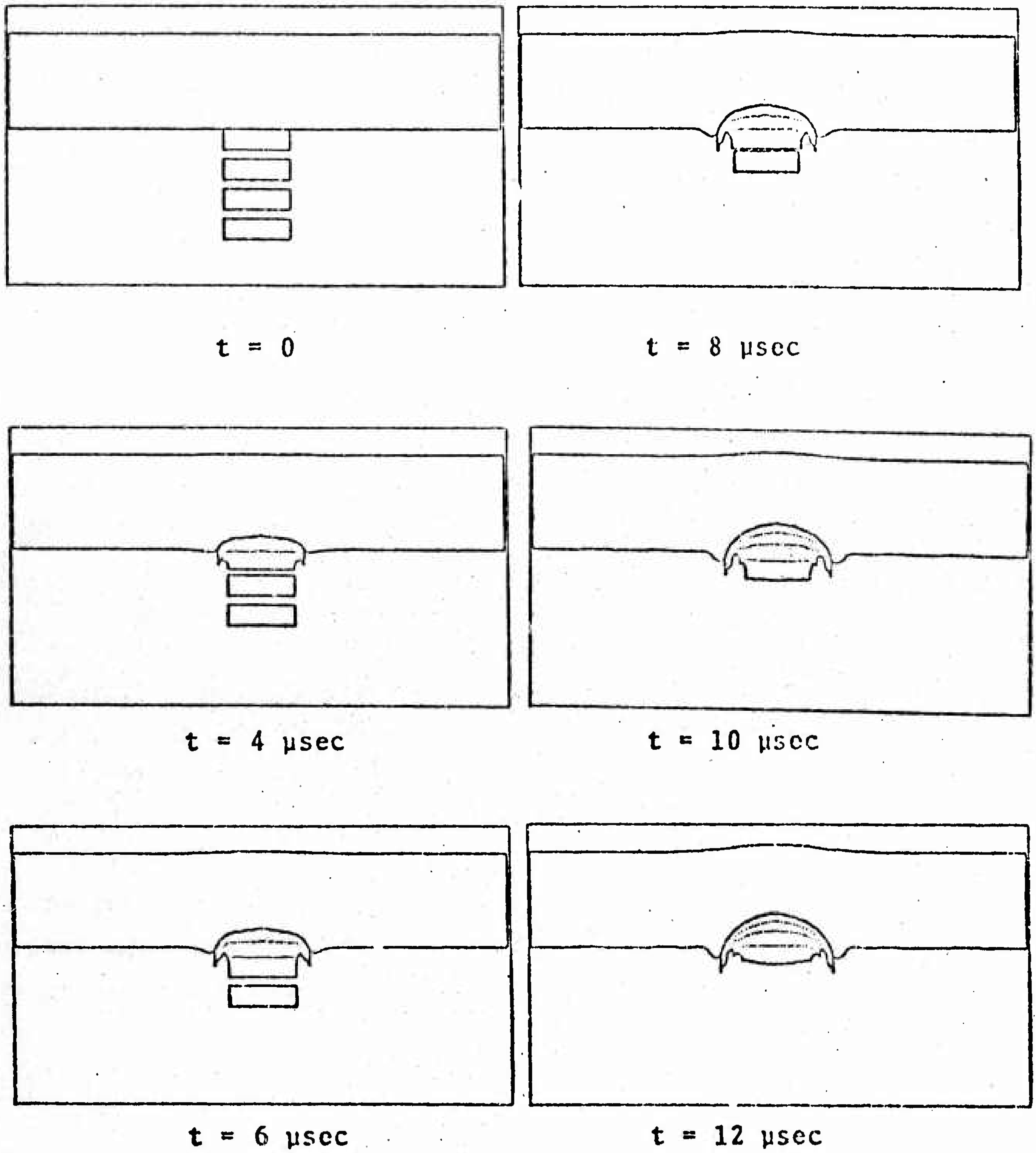


Figure 12.14--Projectile-target configurations at various times for the spaced pellet projectile impact.

12.5 FRAGMENTATION MUNITIONS

This subsection presents results from a HELP solution to a fragmentation munitions problem. The calculation involved a hollow steel cylinder filled with Octol. Detonation was end-initiated at a point on the axis. This calculation was taken from a high explosive parameter study [20]. Figure 12.15 shows the initial configuration for the calculation.

The high explosive-casing configurations for various times after detonation initiation are shown in Figure 12.16. The calculation was continued in time until failure had been predicted throughout the entire casing. The maximum pressure in the detonated products by that time had been reduced to approximately one kilobar and the casing acceleration was small.

Figure 12.17 is a composite plot of the casing at various times after detonation initiation. The shaded regions, which indicate failed material, show that failure occurs first at the outside surface of the casing and moves inward until the entire casing has failed. In the calculation the stresses in failed cells were set to zero.

Figure 12.18 gives the HELP predictions of fragment velocity and projection angle. These quantities are plotted versus the initial relative position of the fragment and are compared with experimental data provided by the BRL [21].

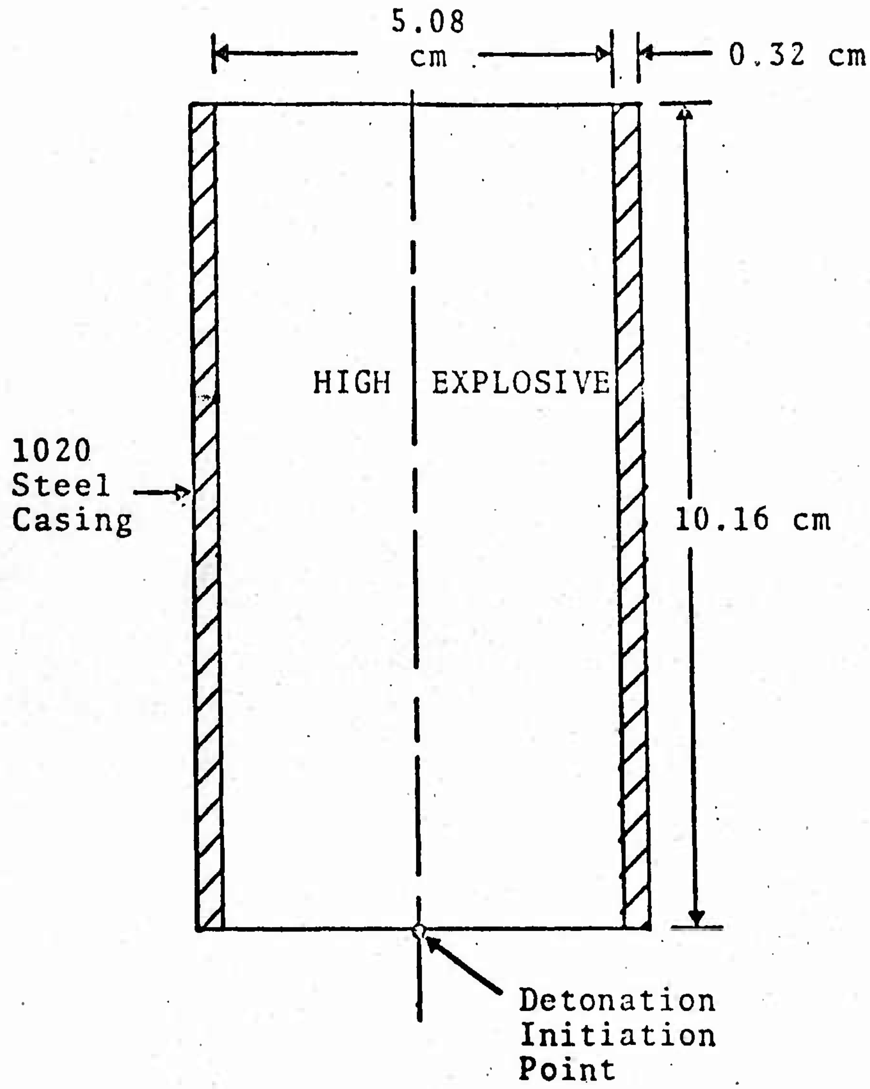


Figure 12.15--Initial configuration of the fragmentation munition solution. The high explosive employed was Octol.

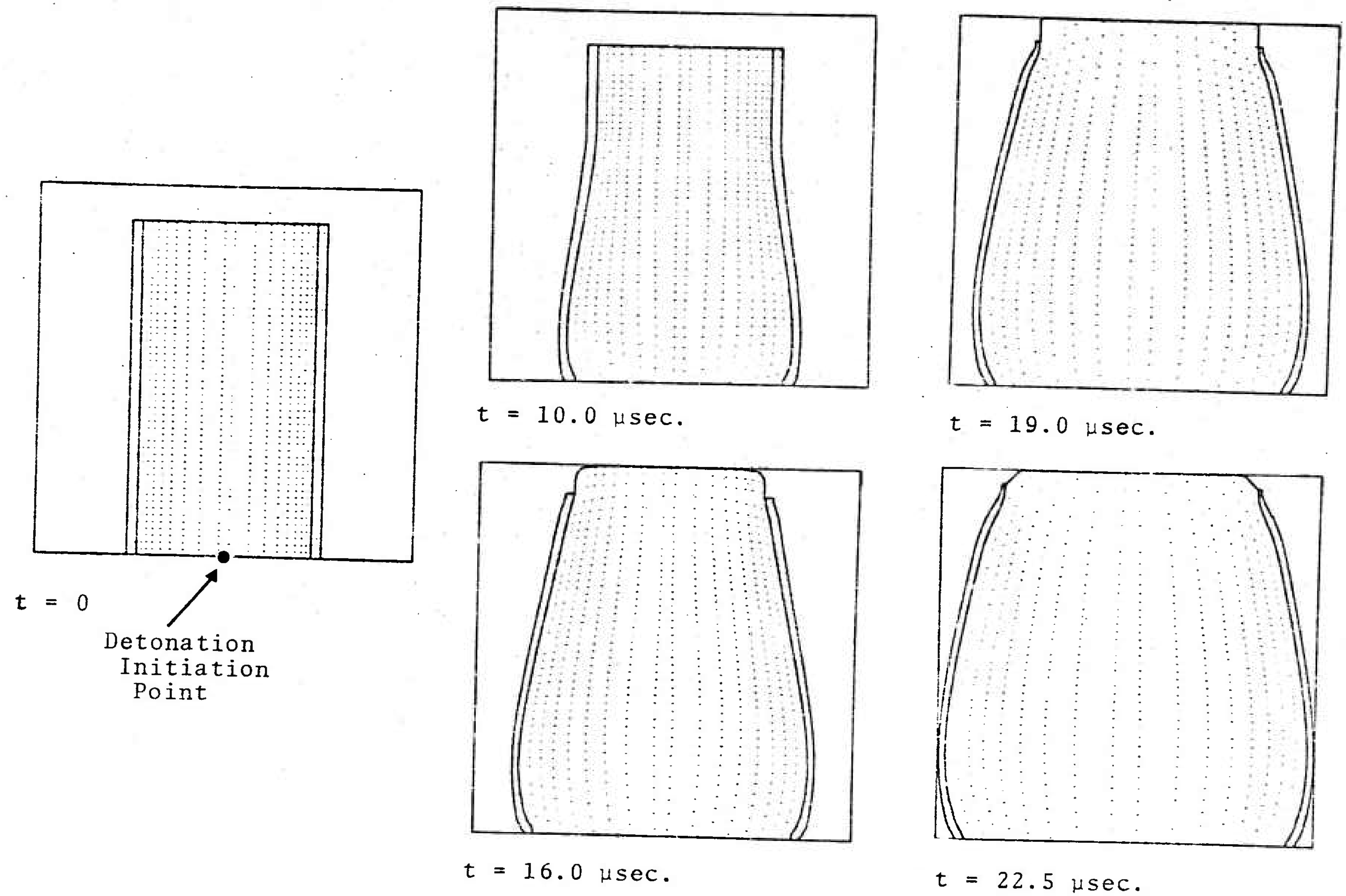


Figure 12.16--High explosive-metal casing configurations at various times.

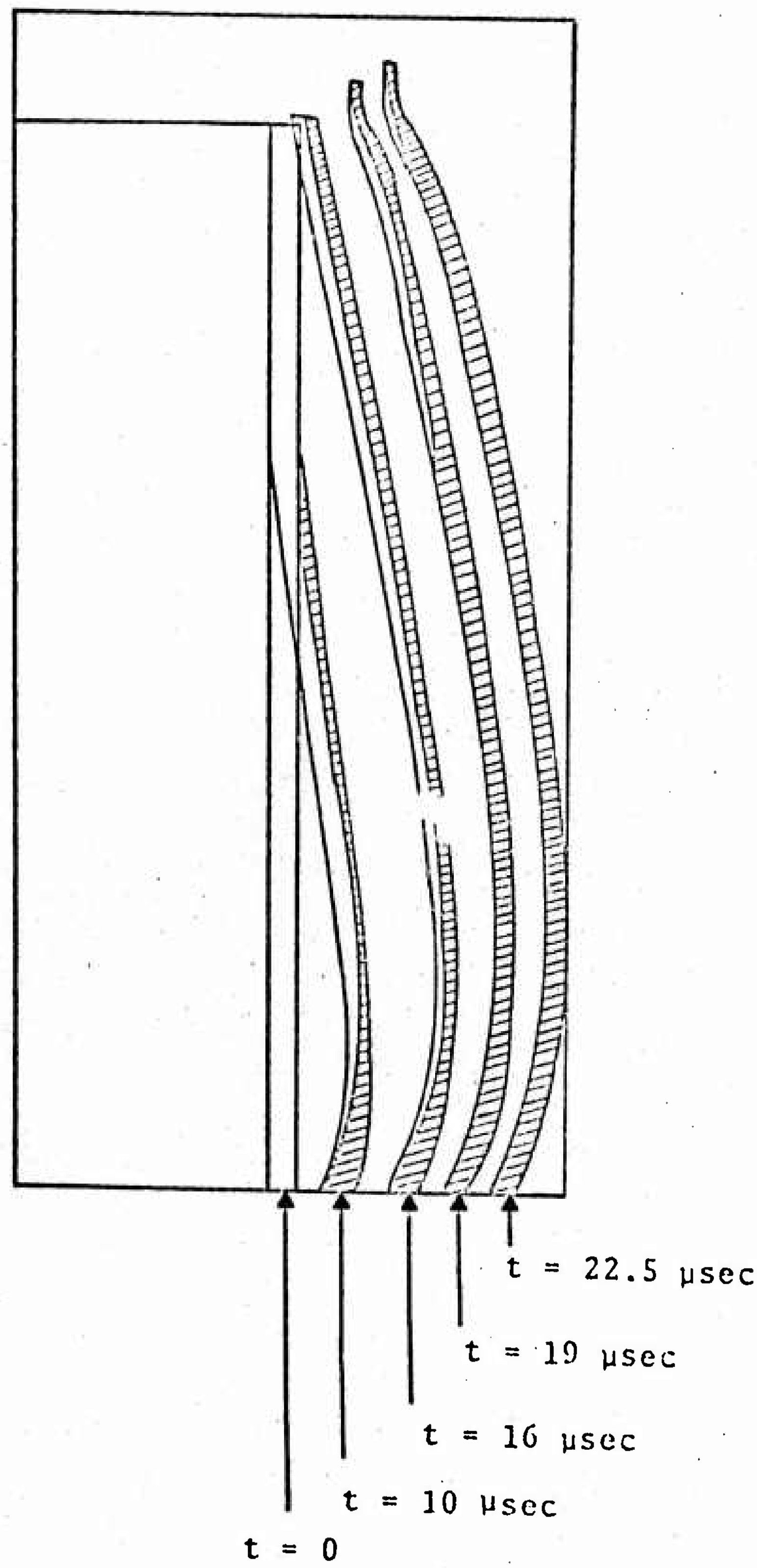


Figure 12.17--Casing configuration at various times. Cross-hatched regions indicate material failure.

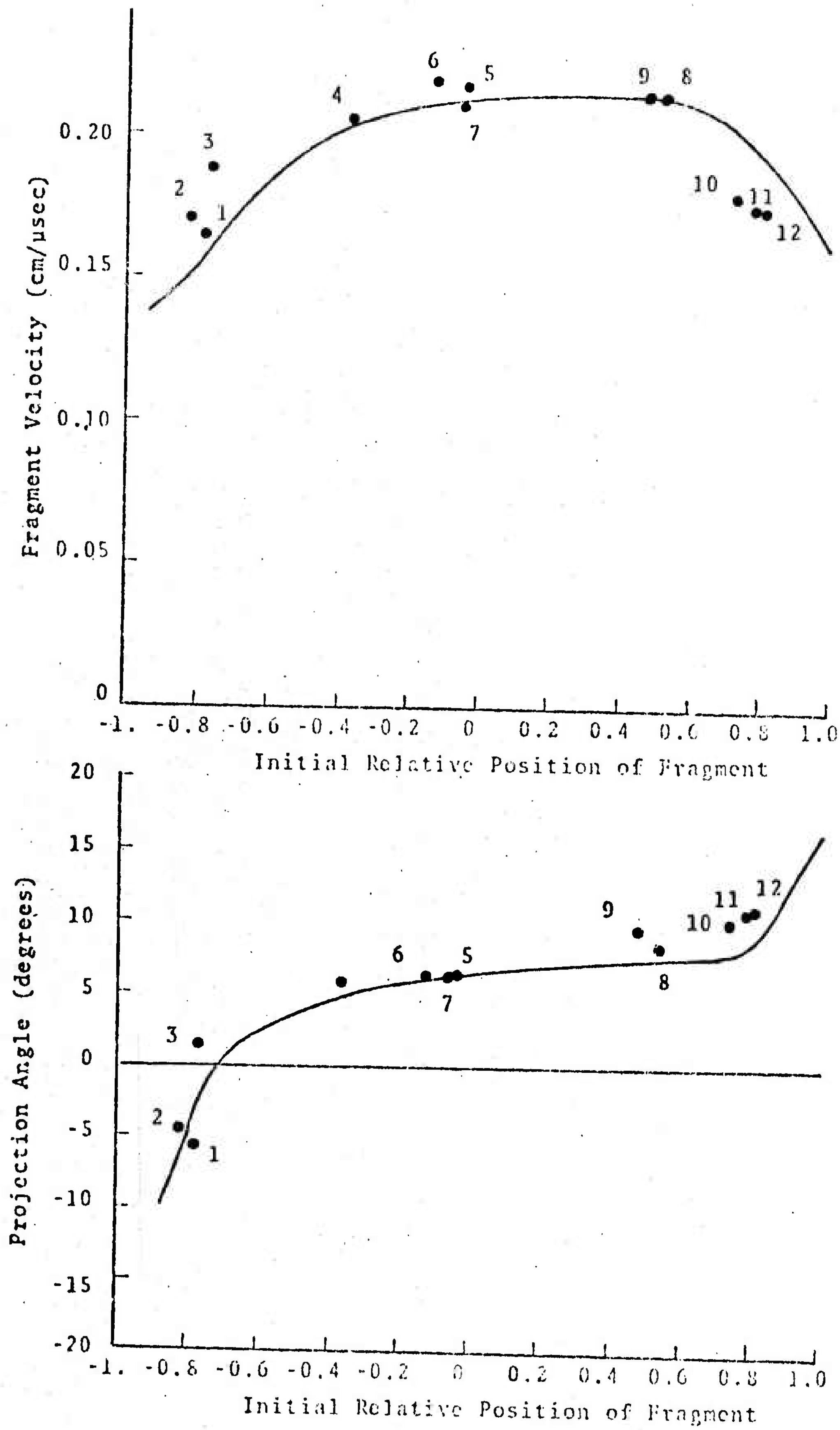


Figure 12.18--Plots of fragment velocity and projection angle versus initial relative position of fragment. The solid lines are HELP predictions and the points were determined experimentally [21].

12.6 SHAPED CHARGE JET FORMATION

Recently HELP was used to perform several numerical studies involving shaped charge jet formation [22-26]. The results shown here are selected from Reference 26 and involve identical copper liners (21° half angle) and Comp B high explosive, but different casings. Figure 12.19 shows the initial configurations of the two selected calculations, and Figure 12.20 and 12.21 show the predicted configurations at various times after initiation for the charges confined in aluminum and steel, respectively. Transmittive boundaries at the bottom of the calculational grid allow the jet material to leave the grid; however, quantities of interest such as jet mass and velocity are retained.

Experimentally determined jet tip velocity data were made available by the BRL [27] for comparison with the results obtained from the calculations involving aluminum confinement. Figure 12.22 is a plot of calculated jet velocities versus the measured jet tip velocities. The open circles correspond to the maximum calculated jet velocities. These calculated maxima did not occur at the jet tip because of the inverse velocity gradient in that region, but they do fall well within the 10% error limit shown by the dashed lines in Figure 12.22. However they are consistently slightly lower than the observed values. This is probably due to the fact that numerically calculated detonation fronts are somewhat broader than real detonation fronts, a result expected unless extremely fine resolution is employed in the calculations.

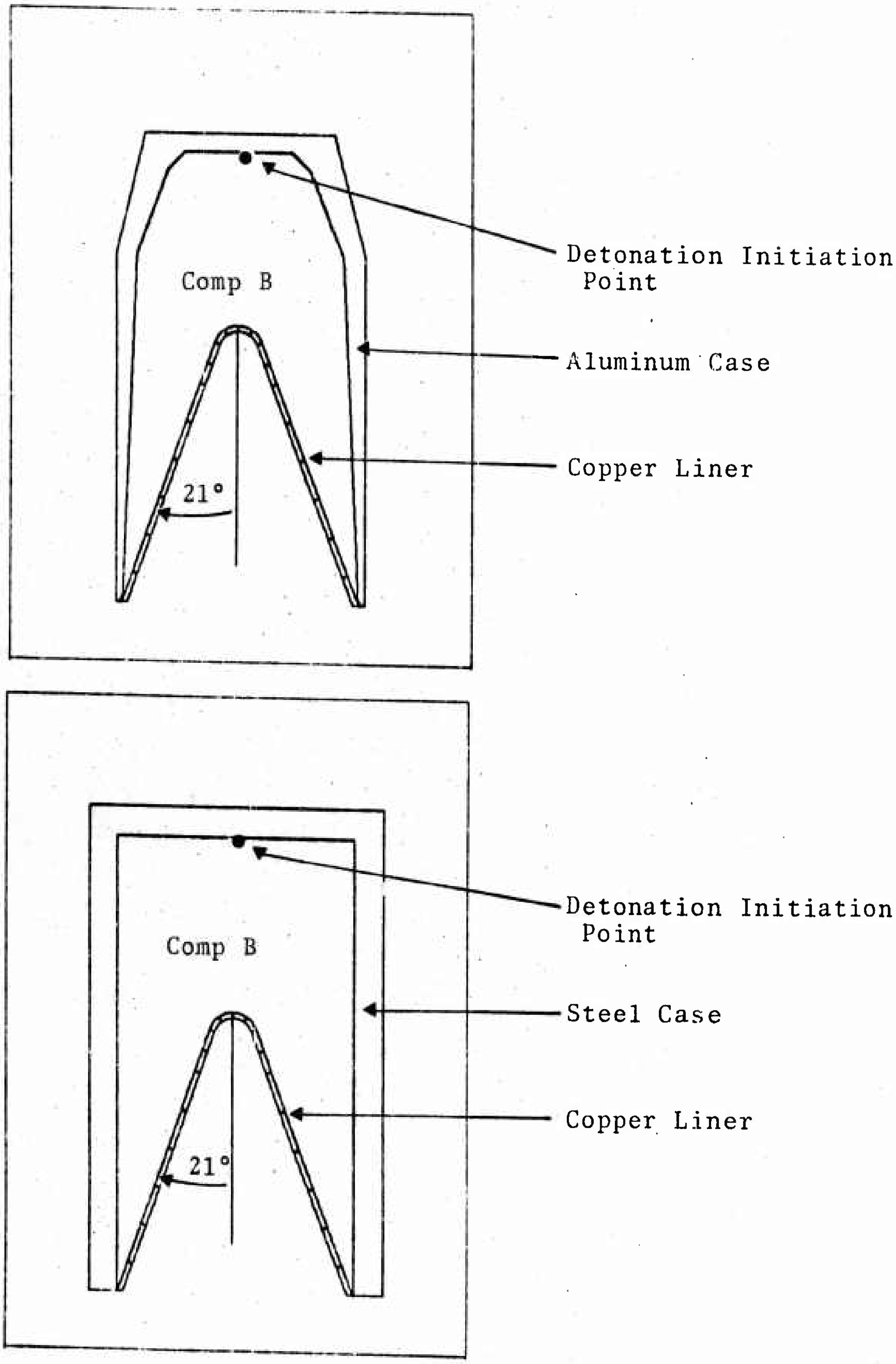


Figure 12.19--Initial configurations of two calculations involving copper liners, Comp B high explosive, and light (aluminum) and heavy (steel) casings.

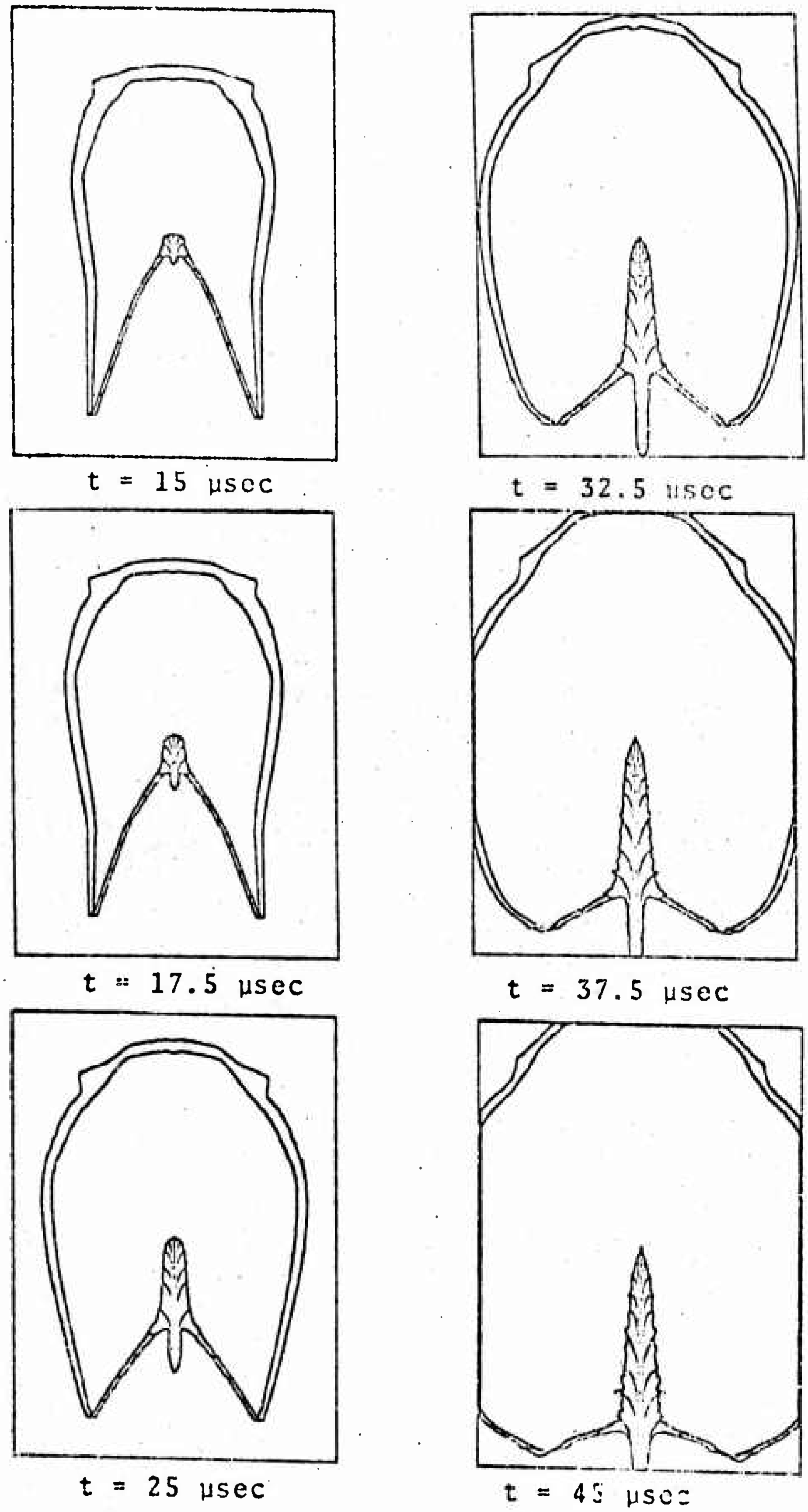


Figure 12.20--Predicted configuration at various times for copper shaped charge with aluminum case.

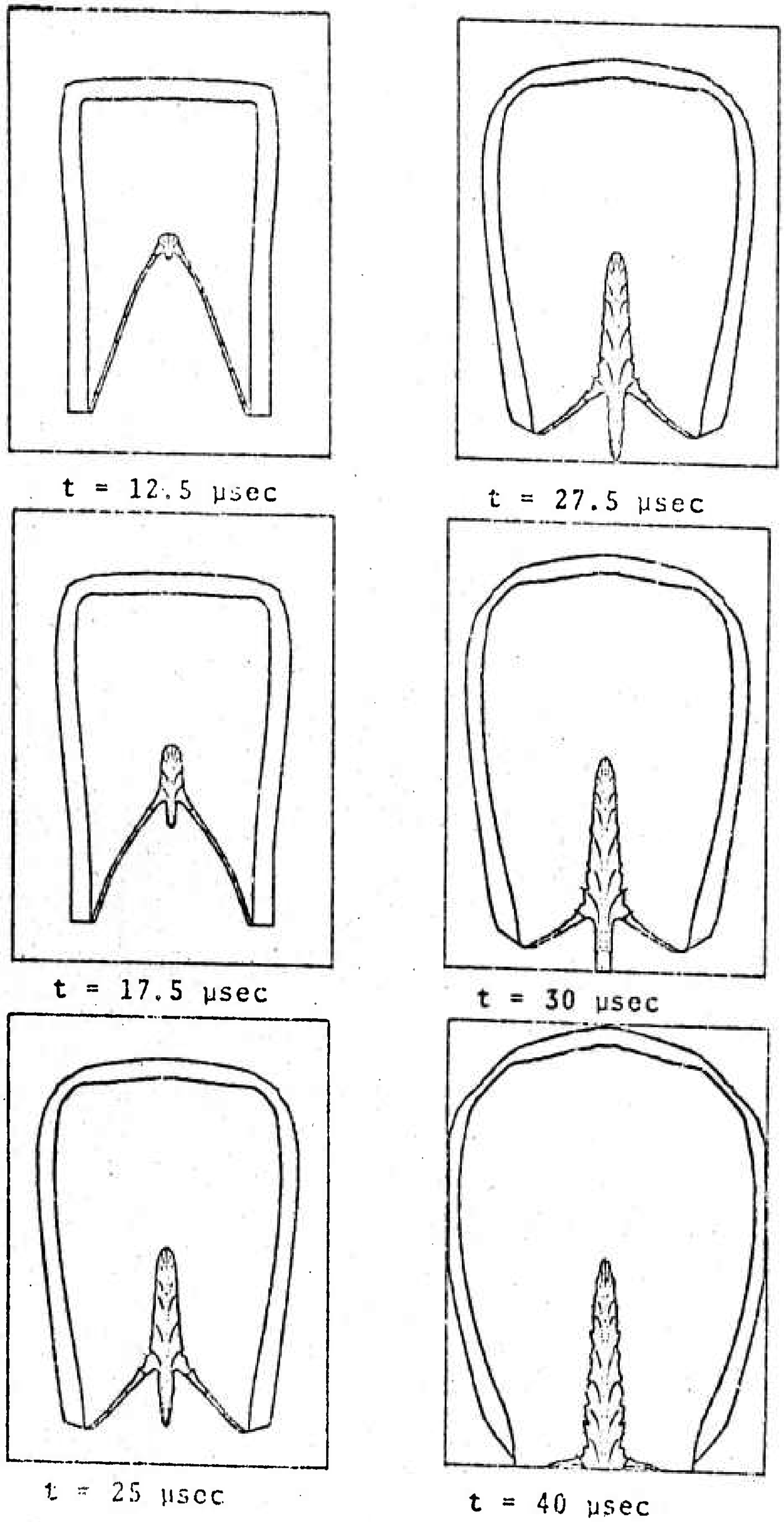


Figure 12.21--Predicted configuration at various times for copper shaped charge with steel case.

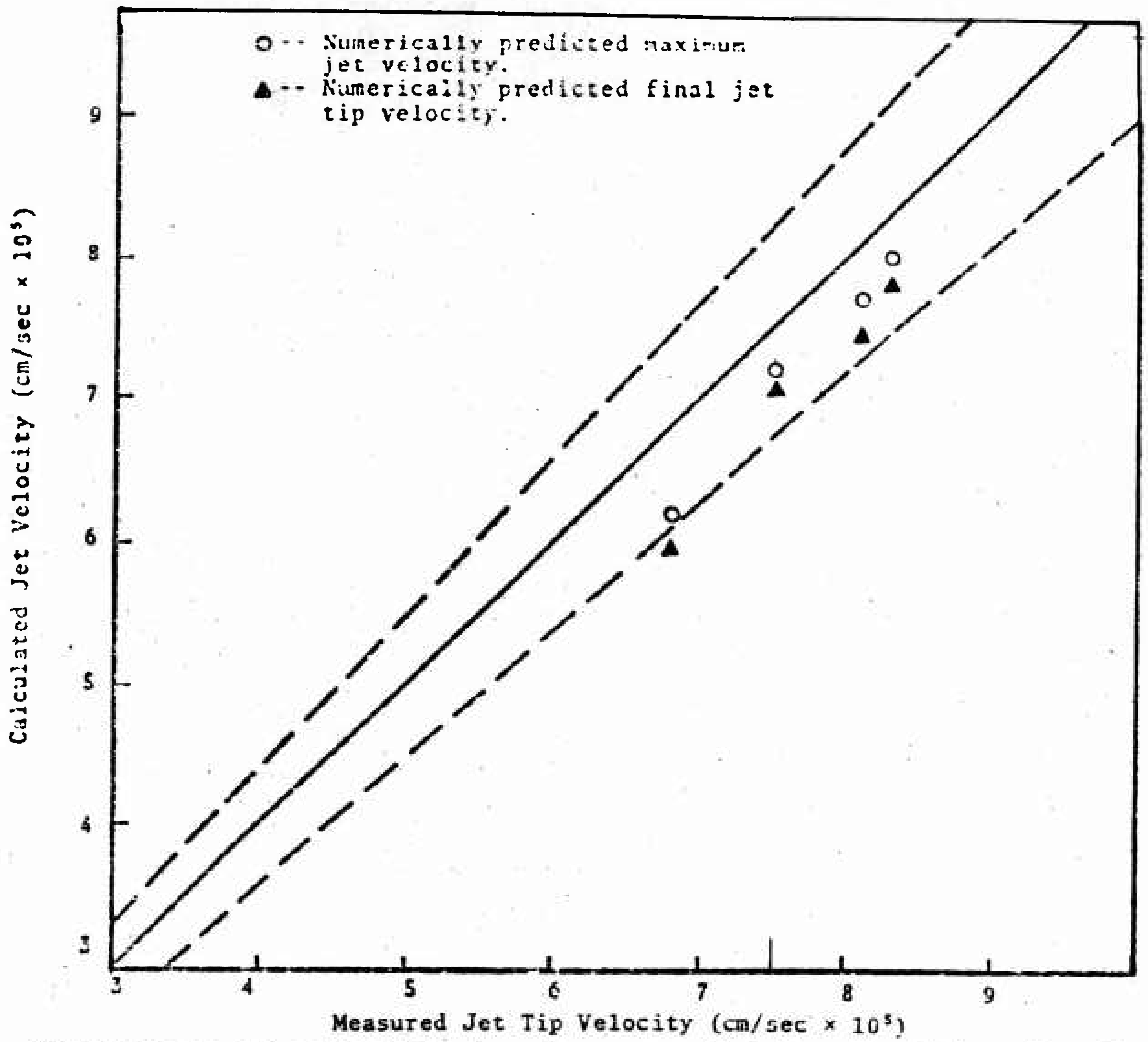


Figure 12.22--Comparison of calculated and measured jet velocities for four shaped charge calculations of Ref. 26. The dashed lines bound the region in which disagreement between theory and experiment is less than 10%.

12.7 SHAPED CHARGE JET PENETRATION

The HELP code has also recently been employed in an investigation involving shaped charge jet penetration of an armor plate [28, 29]. The calculations were carried out in time until the jet perforated the armor and the region of predicted material failure, which gives rise to behind-the-armor debris, had ceased to grow.

The initial conditions for the calculation presented here involve a copper jet having a bulb at the tip, impacting a 2.54 cm thick steel plate at a constant velocity of 7.6×10^5 cm/sec. The bulb, which comprised the leading 3.81 cm of the jet, was described by a straight line connecting the 1.27 cm diameter hemispherical tip to the constant diameter portion of the jet. Figure 12.23 shows the predicted jet and armor configurations at various times after impact. Figure 12.24 shows the predicted configuration 10.30 μsec after initial impact, with the failed cells shaded. The total stress components were set to zero in all of the failed cells.

Some of the results from the calculation can be compared with available experimental data obtained from the BRL. Figure 12.25 is a comparison of the numerically predicted debris cloud, the leading edge of which is shown at various times after impact, with a radiograph of actual behind-the-armor debris. The numerical prediction agrees well with the experiment.

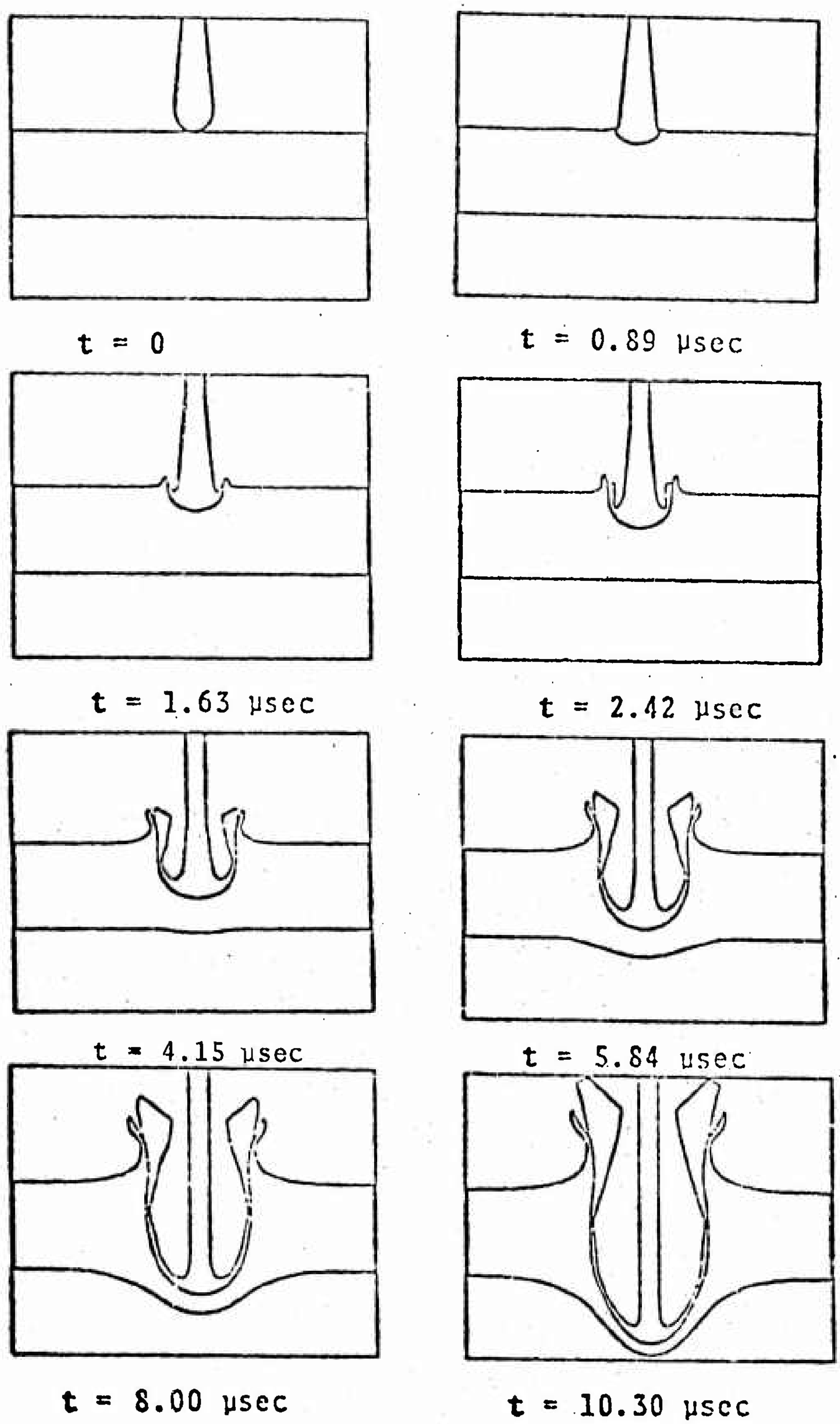


Figure 12.23--Predicted jet and armor configurations at various times after impact.

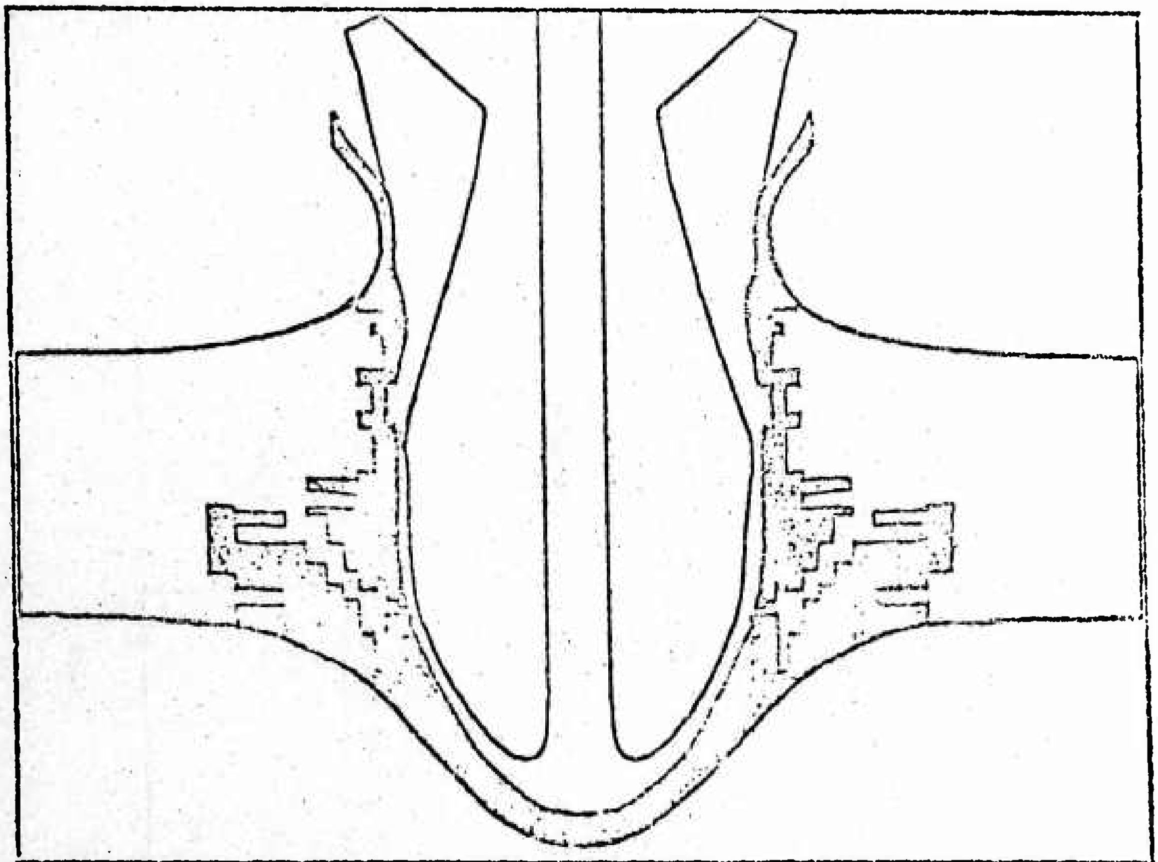


Figure 12.24--Predicted configuration at t = 10.30 μsec after initial impact of shaped charge jet with armor plate. Failed cells are shaded.

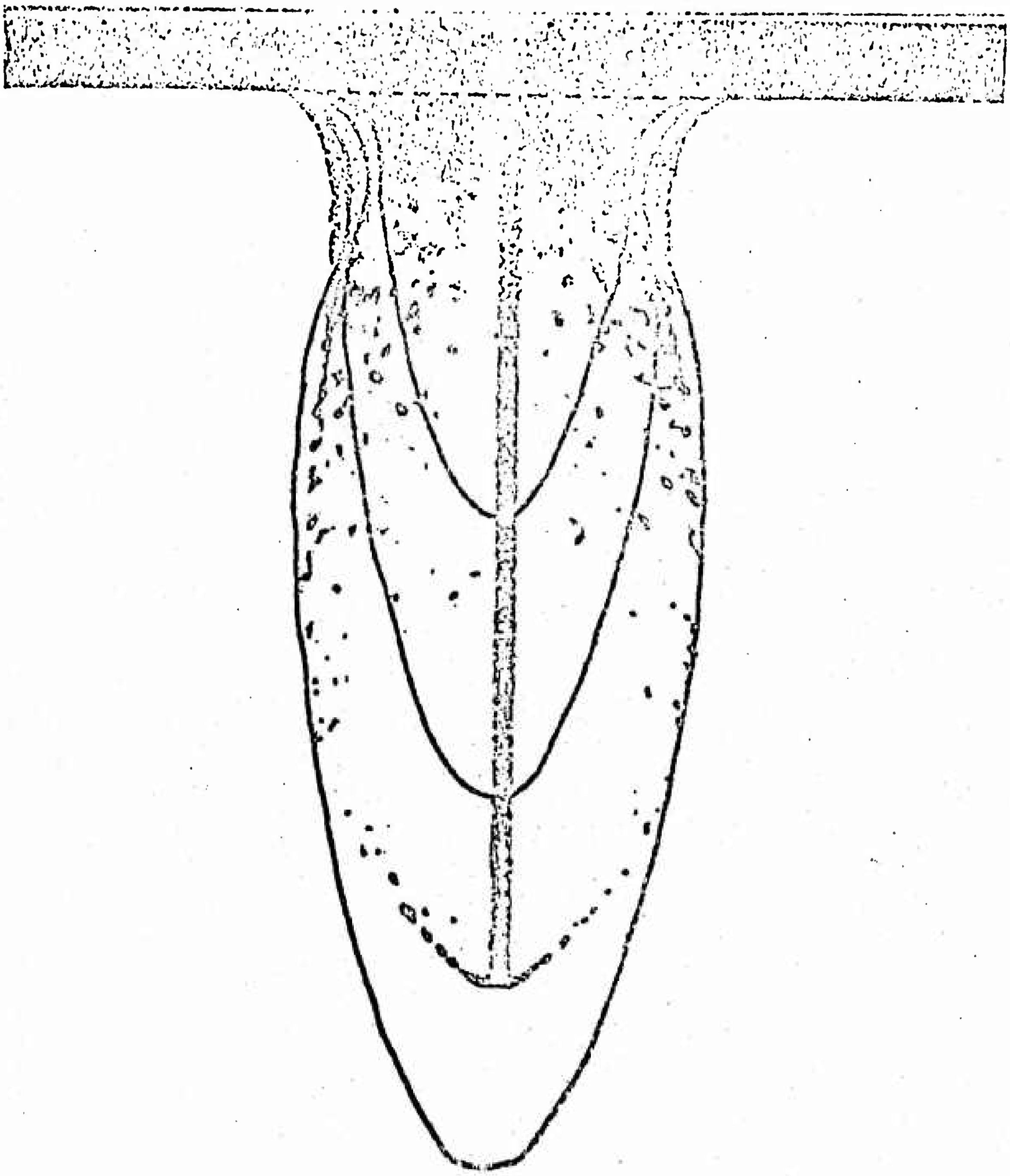


Figure 12.25--Radiograph of behind-the-armor debris superimposed upon the predicted shape of the debris cloud shown at various times after impact.

12.8 WAVE PROPAGATION STUDY

The HELP code has also been applied to the study of wave propagation in various media. A series of calculations was performed using a nitromethane source buried in media of various porosities [30]. Stress-time histories were obtained at stations located at several ranges from the center of the charge and compared with experimental results [30]. Some of these calculated histories, and associated data points, are presented in Figures 12.26 - 12.29. The first three figures were obtained at shot depth, at a radius of 3 meters from the center of the source, in soils of increasing porosity. The last figure, obtained in the calculation of the soil having the least porosity, is the history at the station 6 meters from the center of the source at shot depth.

Figures 12.26 - 12.28 show clearly the attenuation of the shock strength as the soil porosity increases. Each of the figures gives excellent agreement with the data as regards shock strength, time of arrival, and the shape of the release curve. Figure 12.29 shows that the agreement was obtained even at stress levels on the order of 1 kilobar.

It is worth noting that Figures 12.27 and 12.28 were calculated as part of a design study prior to the field experiment from which the data were obtained. The other two figures were calculated subsequent to the running of the experiment.

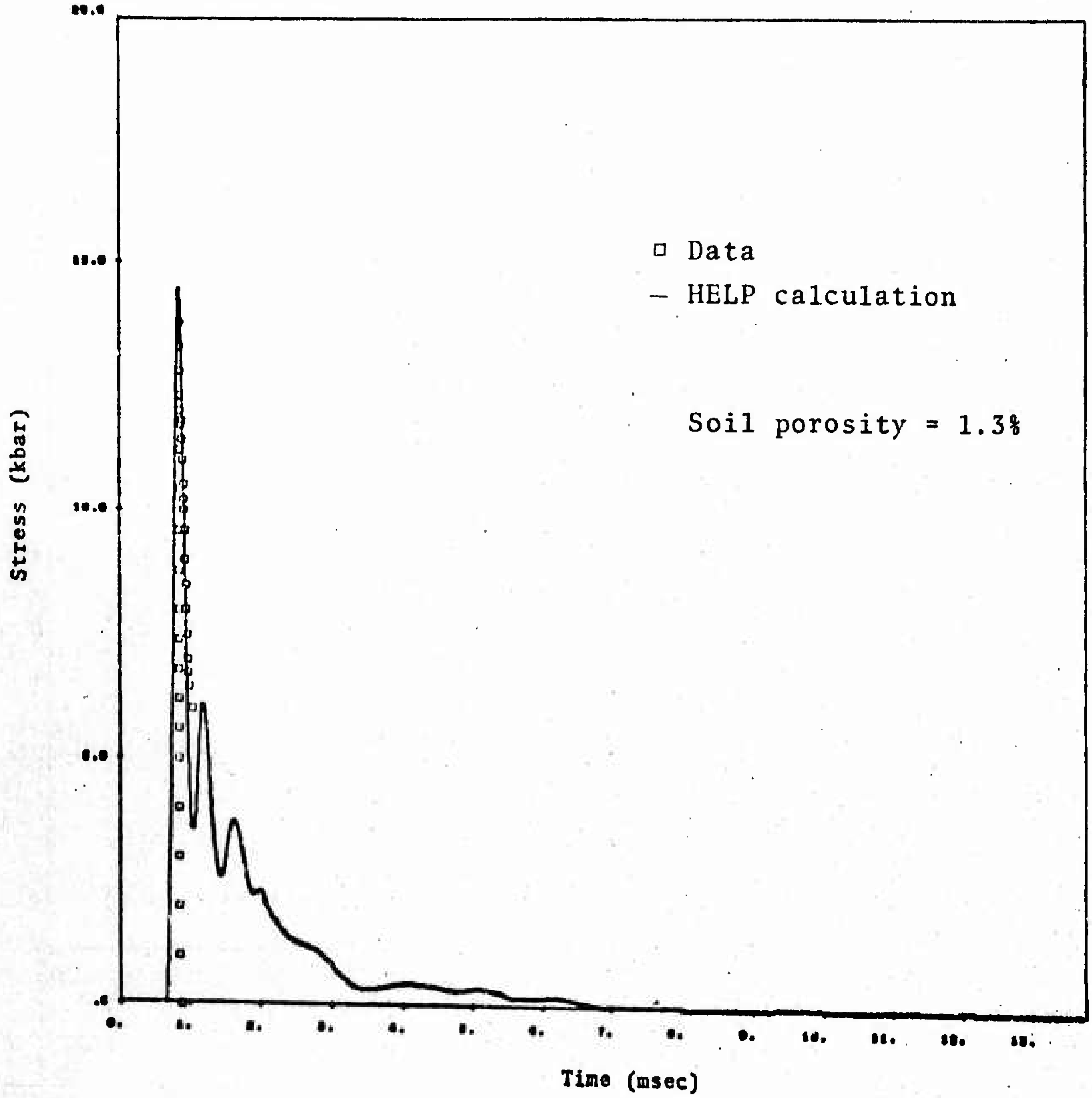


Figure 12.26--Predicted stress history of 3 meter station at shot depth for nitromethane source in 1.3% porosity soil. Data is from a test of the source in that material.

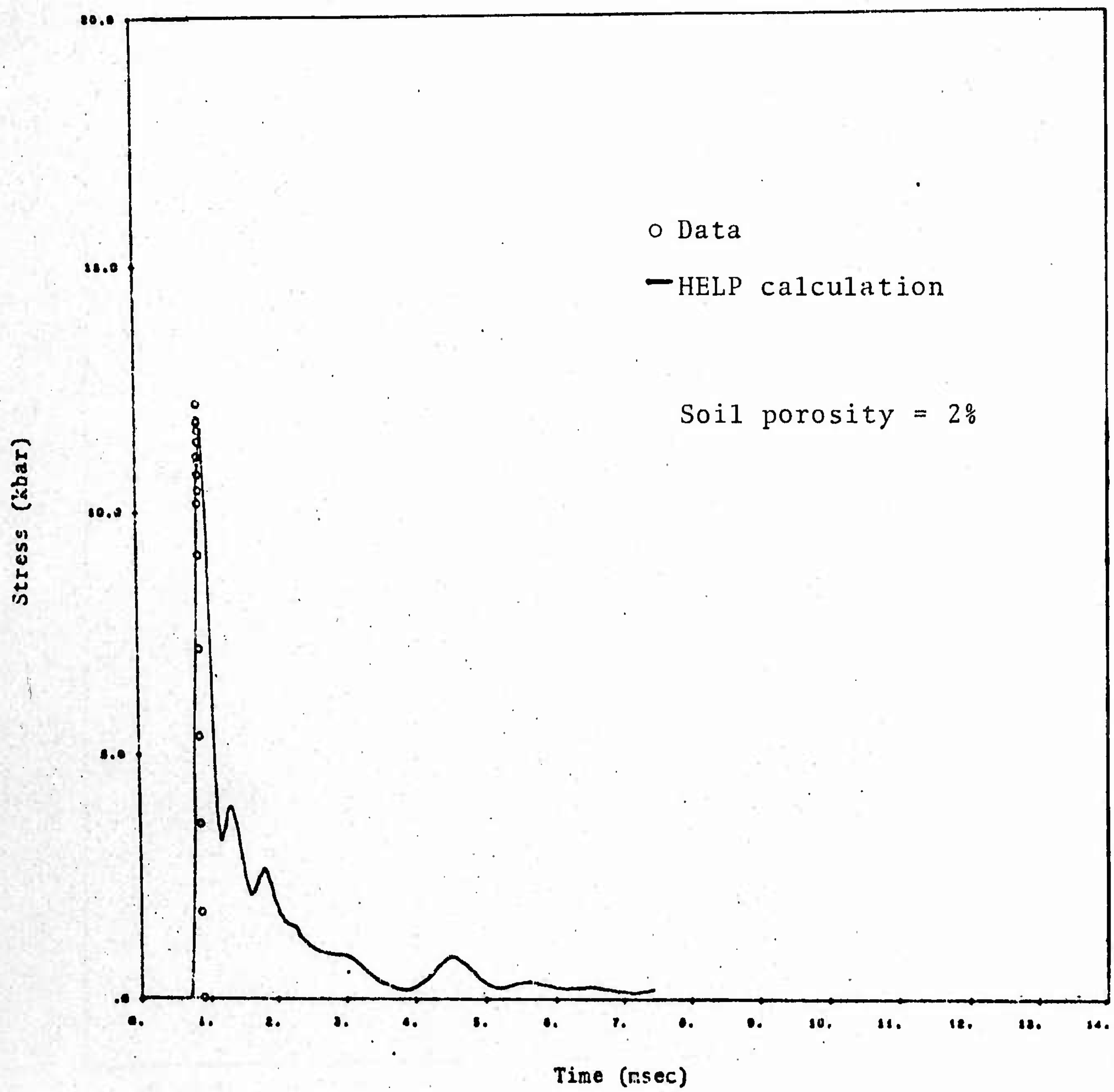


Figure 12.27--Predicted stress history of 3 meter station at shot depth for nitromethane source in 2% porosity soil. Data is from a test of the source in that material.

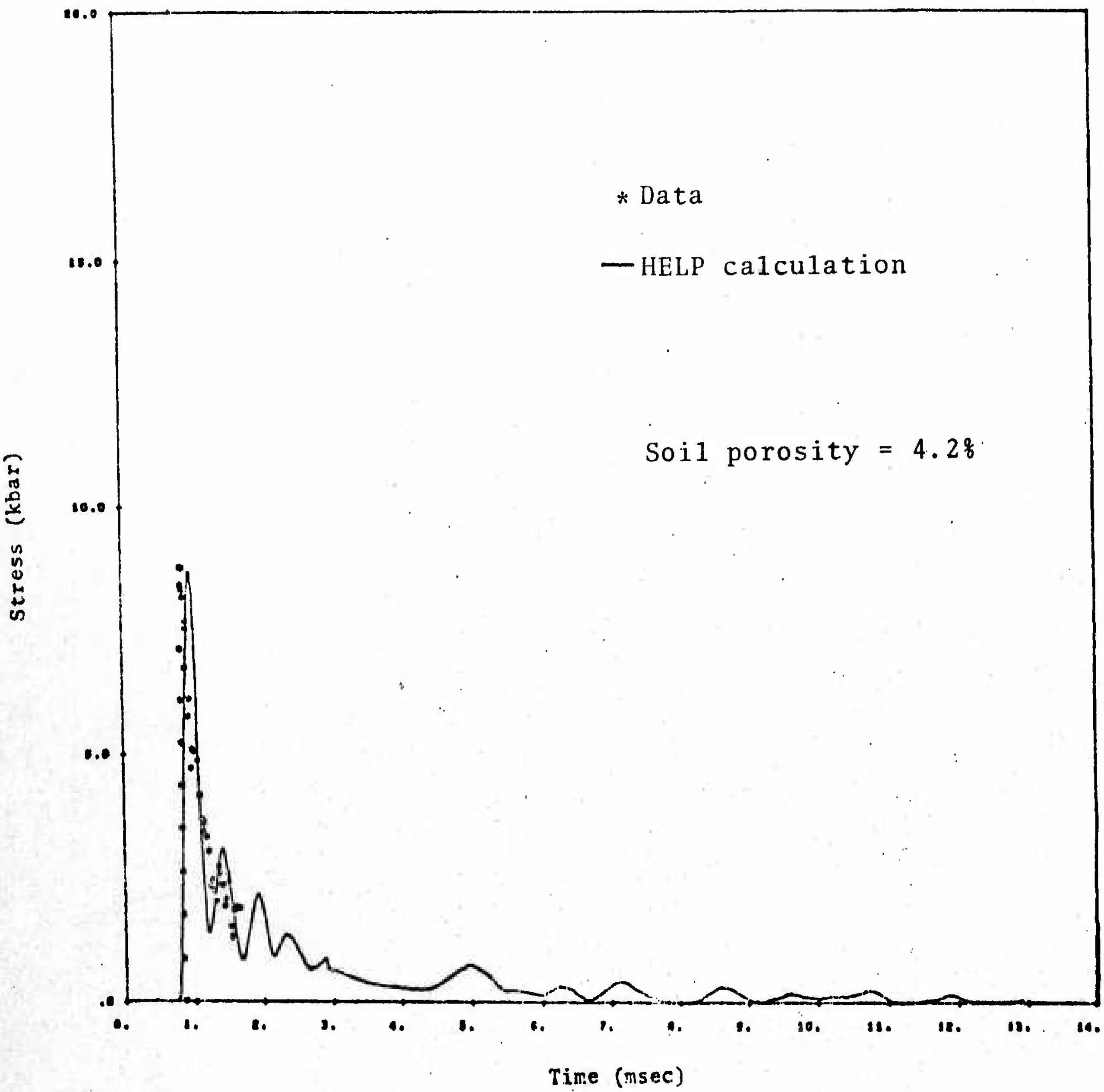


Figure 12.28--Predicted stress history of 3 meter station at shot depth for nitromethane source in 4.2% porosity soil. Data is from a test of the source in that material.

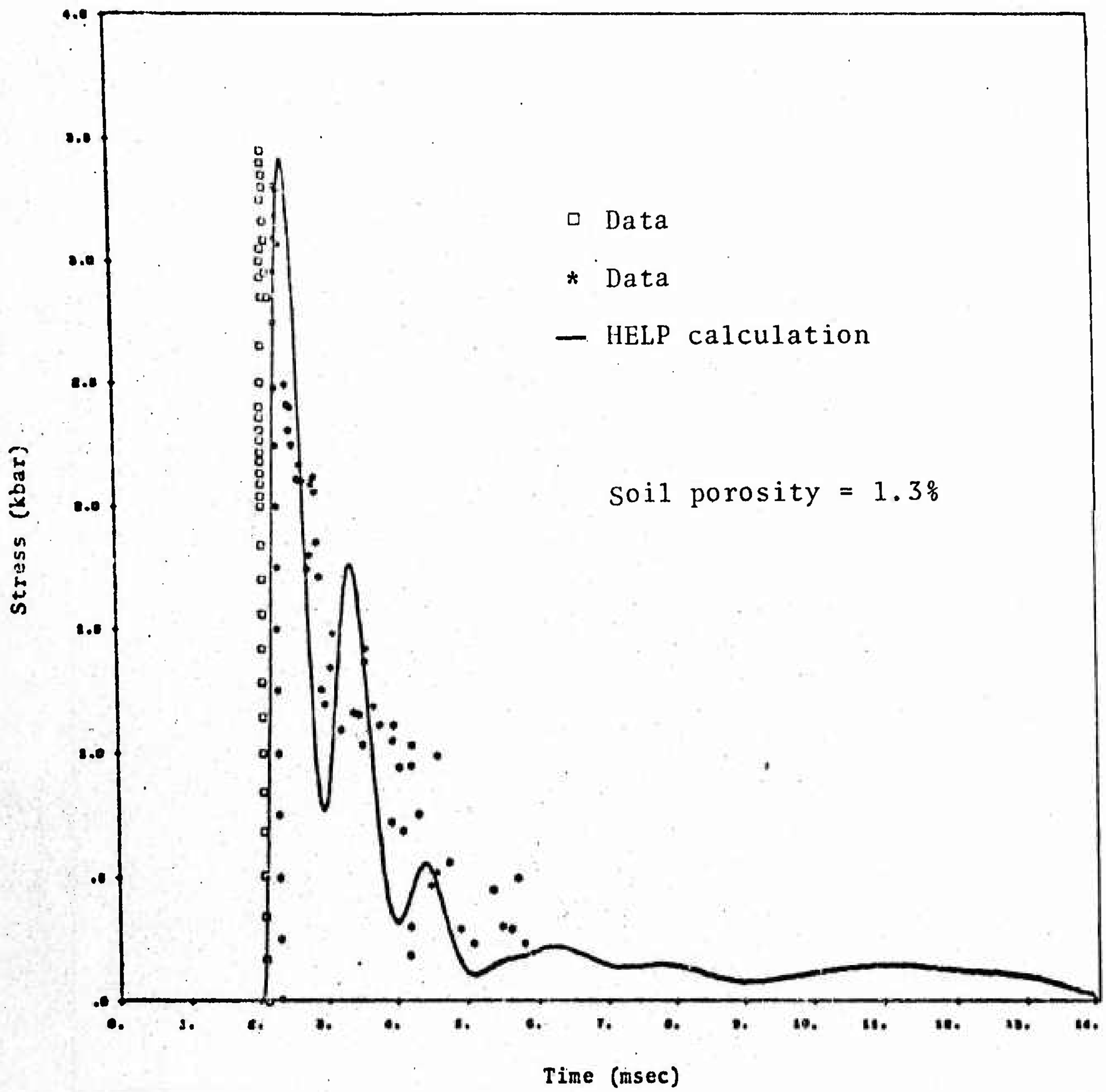


Figure 12.29--Predicted stress history of 6 meter station at shot depth for nitromethane source in 1.3% porosity soil. Data is from two different tests of the source in that material.

REFERENCES

1. Hageman, L. J. and J. M. Walsh, "HELP, A Multi-material Eulerian Program for Compressible Fluid and Elastic-Plastic Flows in Two Space Dimensions and Time," Systems, Science and Software, 3SR-350, August 1970.

2. Dienes, J. K., M. W. Evans, L. J. Hageman, W. E. Johnson and J. M. Walsh, "An Eulerian Method for Calculating Strength Dependent Deformation," General Atomic Report GAMD-8497, Parts I, II, III and Addendum, AD 678565, 678566, 678567, and 678568, February 1968.

3. Johnson, W. E., "OIL, A Continuous Two-Dimensional Eulerian Hydrodynamic Code," General Atomic Report GAMD-5580 Revised, January 1965.

4. Harlow, F., and M. Evans, "The Particle-in-Cell Method for Hydrodynamics Calculations," Los Alamos Scientific Laboratory Report LA-2139, 1957.

5. Sedgwick, R. T. and L. J. Hageman, "Numerical, Analytical, and Experimental Investigation of Penetration by Kinetic Energy Projectiles," AFATL-TR-72-48, March 1972.

6. Sedgwick, R. T., M. S. Chawla and L. J. Walsh, "Parametric Application of Computer Codes to Metallic Projectile/Target Interactions," AFATL-TR-73-103, April 1973.

7. Sedgwick, R. T., L. J. Walsh and M. S. Chawla, "Effects of High Explosive Parameters and Degree of Confinement on Jets from Lined Shaped Charges," Systems, Science and Software, SSS-R-75-2515, December 1974.

8. Sedgwick, R. T., A. J. Good and L. J. Hageman, "Theoretical Investigation of High Explosive Fragmentation Munitions," Systems, Science and Software, 3SR-867, November 1971.

9. Sedgwick, R. T., J. L. Waddell and L. J. Walsh, "A Theoretical Investigation of Several High Explosive-Metal Systems," Systems, Science and Software, SSS-R-74-2055, January 1974.

10. Lee, E., M. Finger and W. Collins, "JWL Equation of State Coefficients for High Explosives," Lawrence Livermore Laboratory, UCID-16189, January 1973.

REFERENCES

11. Tillotson, J. H., "Metallic Equations of State for Hypervelocity Impact," General Atomic Report GA-3216, July 1962.

12. Sedgwick, R. T., M. S. Chawla, J. L. Waddell, L. J. Walsh and D. E. Wilkins, "Research Study and Analysis For Improvement of Shaped Charge Code," Systems, Science and Software, SSS-R-73-1862, August 1973.

13. Walsh, J. M. and R. T. Sedgwick, "Studies of Erosion and Impact Resistance of ABM Materials," Systems, Science and Software, SSS-R-74-2399, Contract DAAD05-73-C-0339, November 1974.

14. Sedgwick, R. T. and L. J. Hageman, "Numerical, Analytical and Experimental Investigation of Penetration by Kinetic Energy Projectiles," Systems, Science and Software Progress Report 3SR-670 under Contract F08635-71-C-0094, April 15, 1971.

15. Hageman, L. J. and R. T. Sedgwick, "Modifications to the HELP Code for Modeling Plugging Failure: User's Manual," AFATL-TR-72-106, June 1972.

16. Sedgwick, R. T., M. S. Chawla and L. J. Walsh, "Parametric Application of Computer Codes to Metallic Projectile/Target Interactions," Systems, Science and Software, Air Force Armament Laboratory Report AFATL-TR-73-103, April 1973.

17. Sedgwick, R. T. and L. J. Hageman, "A Numerical Model For Plugging Failure," Proceedings of an International Conference on Dynamic Crack Propagation, July 1972.

18. Sedgwick, R. T., L. J. Hageman and J. L. Waddell, "A Comparison of Results From Two Long Rod Oblique Impact Calculations," Systems, Science and Software, SSS-R-75-2656, June 1975.

19. Walsh, J. M. and R. T. Sedgwick, "The Application of Computers to Kinetic Energy Projectiles," presented at JTCG/ME meeting held at Ballistics Research Laboratory February 13-14, 1973.

20. Sedgwick, R. T., A. J. Good and L. J. Hageman, "Theoretical Investigation of High Explosive Fragmentation Munitions," Final Report, Contract DAAD 05-71-C-0092, Systems, Science and Software Report 3SR-867, November 24, 1971.

REFERENCES

21. S. Kronman and C. Brown, private communication, data obtained at the Ballistic Research Laboratories.

22. Gittings, M. L., R. T. Sedgwick and J. M. Walsh, "Numerical Analysis of Jet Formation from Lined Shaped Charges," Systems, Science and Software, Ballistic Research Laboratories Contract Report No. 51, August, 1971.

23. Sedgwick, R. T., M. S. Chawla, J. L. Waddell, L. J. Walsh and D. E. Wilkins, "Research Study and Analysis for Improvement of Shaped Charge Code," Systems, Science and Software, Contract No. DAAD 05-72-C-0291, Final Report, August 31, 1973.

24. Walsh, L. J., D. E. Wilkins and R. T. Sedgwick, "User's Manual for an Eulerian Shaped Charge Computer Program," Systems, Science and Software, Air Force Armament Laboratory Report AFATL-TR-73-24, February 1973.

25. Sedgwick, R. T., M. L. Gittings and J. M. Walsh, "Numerical Techniques for Shaped Charge Design," Systems, Science and Software, presented at 12th Annual Symposium, New Mexico Section American Society of Mechanical Engineers and University of N. M. College of Engineering, March 2-3, 1972.

26. Sedgwick, R. T., L. J. Walsh and M. S. Chawla, "Effects of High Explosive Parameters and Degree of Confinement on Jets from Lined Shaped Charges," Systems, Science and Software, SSS-R-75-2515 (Draft), DAAD 05-74-C-0758, December 1974.

27. Simon, J., "The Effect of Explosive Detonation Characteristics on Shaped Charge Performance," BRLM-2414, September 1974.

28. Sedgwick, R. T., P. L. Anderson, M. S. Chawla, C. R. Hastings and L. J. Walsh, "Characterization of Behind-the-Armor Debris Resulting From Shaped Charge Jet Perforation," Systems, Science and Software, SSS-R-74-2081, Final Report, DAAD 05-73-C-0542, June 1974.

29. Sedgwick, R. T. and L. J. Walsh, "Numerical Techniques for Modeling Armor Penetration and Behind-the-Armor Debris," Proceedings of the First International Symposium on Ballistics, Orlando, Fla., November 13-15, 1974.

REFERENCES

30. Blake, T. R. and D. E. Wilkins, "Simulation of Low Yield, Buried Nuclear Explosions by High Explosive Detonation, ESSEX I - Phase I, Calculations (U)," Defense Nuclear Agency Report DNA 3572F, 1975. (Confidential)

APPENDIX A

DIMENSIONING THE ARRAYS

Dimensioning the arrays of the HELP code to enable it to handle problems of arbitrary size (limited only by the core memory of the user's computer) is a relatively straightforward procedure. It is necessary only to specify 16 primary parameters and 22 secondary parameters in order to uniquely determine all array dimensions and equivalences in the HELP code.

The primary parameters are listed in Table A1, along with a description of each and, when it exists, the name of the corresponding HELP variable. Because of equivalencing between various arrays, there are constraints placed on the values assigned to some of these parameters. These constraints are listed in Table A2.

After the user has determined the values of the 16 primary parameters, it is necessary to determine another 22 secondary parameters, which are functions of the primary parameters. These secondary parameters are defined in Table A3.

Having defined these parameters, all that remains is for the user to incorporate their values into the common, dimension, and equivalence statements that use parameter rather than integer dimensions. Most of these statements are in the "included" element, and the remaining ones are in subroutine SPHASE. Any arrays which are dimensioned by integer values (not parameters) are fixed and should not be redimensioned.

TABLE A.1

PRIMARY PARAMETERS FOR DIMENSIONING THE HELP CODE

Parameter	Definition*
MDX	Maximum number of interface cells which can occur on any one cycle. (NMXCLS)
NMX	Number of material packages in the problem, excluding the void package. (NMAT)
NTPX	Maximum number of material tracer particles for any one package in the problem. (NTPMX)
IDX	Number of columns in the grid. (IMAX) See Table A2.
JDX	Number of rows in the grid. (JMAX) See Table A2.
IJDX	If problem is to be rezoned, IJDX is the maximum value of IDX and JDX. Otherwise, it can be set to 1.
KSTR	If problem will compute strength effects (CYCPH3>0), set KSTR to IDX • JDX + 1. Otherwise, set to 1.
IDXX	If problem will compute strength effects, set IDXX to IDX + 1. Otherwise set to 1. This parameter is used only to dimension local variables in SPHASE.

* The analagous HELP variable, if any, is in parentheses.

Parameter	Definition
KDET	If problem will detonate an explosive, set KDET to IDX • JDX + 1. Otherwise, set to 1.
KPX	Dimension of pressure array. See Table A.2 for determining the value of this parameter.
NSLDE	If the problem will have a slip line (NOSLIP=0), set NSLDE to the maximum number of mixed cells which will contain the slip line. Otherwise, set it to 1. (NSLD)
JDX2	Dimension of UL and PL arrays. See Table A.2 for determining the value of this parameter.
IPLGR	If problem is a plugging calculation, set IPLGR to the value of IPLGRT, defined in Section 7.2.1. Otherwise set to 1. (IPLGRT)
IPLGZ	If problem is a plugging calculation, set IPLGZ to the number of rows in the target. Otherwise set to 1. (IPLGTP-IPLGBT + 1.) See definition of IPLGTP and IPLGBT in Section 7.2.1.
KDX4	Maximum number of passive tracer particles the problem will generate. If the problem is a plugging calculation, set KDX4 to 4 • IPLGR • IPLGZ. If passive tracers are not generated (NTCC = 0), set KDX4 to 1. (NTCC)
K4PL	Dimension of PLWP array. If problem is a plugging calculation, set K4PL to 4 • IPLGR • IPLGZ. Otherwise set to 1.

TABLE A.2

CONSTRAINTS ON PARAMETER VALUES

Parameter	Applicable Constraint
IDX	Must be at least 3.
JDX	Must be at least 3.
KPX	Set to maximum value of the following: IDX ● JDX + 1 2 ● (NMX + 1) ● MDX NMX ● (5 ● JDX + 12) 10 ● NMX + (4 + 3 ● NMX) ● IJDX + 2
JDX2	Set to maximum value of the following: IDX 2 ● JDX 6 ● NMX

TABLE A.3

SECONDARY PARAMETERS
FOR DIMENSIONING THE HELP CODE

Parameter	Definition
KDX	IDX·JDX + 1
NMXX	NMX + 1
MDNMX	MDX·NMXX + 1
NMX2	2·NMX + 1
NMX3	3·NMX + 1
NMX4	4·NMX + 1
NMX6	6·NMX + 1
NMX8	8·NMX + 1
NMX10	10·NMX + 1
NMX12	NMX10 + 2
JDXX	JDX + 1
NMXJD	NMX·JDX + NMX4
NMXJD2	2·NMX·JDX + NMX4
NMXJD3	3·NMX·JDX + NMX4
NMXJD4	NMXJD3 + 4·NMX
NMJD	NMXJD4 + 4·NMX
NMJD1	NMJD + NMX·JDX
NMRZ	NMX12 + IJDX
NMRZ2	NMRZ + IJDX
NMRZ3	NMRZ2 +IJDX
NMRZ4	NMRZ3 + NMX·IJDX
NMRZ5	NMRZ4 + NMX·IJDX

APPENDIX B

ABBREVIATED HELP INPUT INSTRUCTIONS

After becoming familiar with the various input options and specifications discussed in Section 7.2, the user can use the following forms to quickly describe the input for a given HELP calculation. The default values of most Z-block variables are given in parentheses after the definition. If no value is specified, the default value is zero.

(Numbers in Parentheses are Non-zero Default Values)

Heading Card →

1	2 3 4 5 6	7	8 9 10 11 12 13 14 15 16	Variable	Description
1	1 5 1	1		PK(1)	Problem number. (Range: 00.0001 to 99.9999)
	1	1		PROB	Problem number, same as PK(1).
2	5	1		NFRELP	Every "NFRELP" EDIT prints is a long print.
2	6	1		NDUMP7	Every "NDUMP7" EDIT prints, a restart dump is written.
2	7	1		ICSTOP	Cycle on which calculation stops if stopping on cycles.
2	1 2	1		NUMREZ	Number of times grid is to be automatically rezoned.
2	1 4	1		KUNITR	Number-name of file INPUT reads from. (7)
2	1 5	1		IPR	Maximum number of iterations to equilibrate pressures in multimaterial cells. (35)
	1 6	1		PRCNT	Convergence limit for pressure iteration (10^{-3})
2	1 7	1		KUNITW	Number-name of file SETUP and EDIT write on. (7)
2	2 1	1		IGM	When IGM=1, code uses plane rather than cylindrical coordinates.
	2 4	1		DMIN	Maximum relative error in energy sum. (10^{-3})
	2 7	1		CVIS	For transmittive bottom grid boundary, CVIS=-1. For reflective bottom grid boundary, CVIS=0.
2	3 3	1		IMAX	Number of columns in grid. (Must be at least 3.)
2	3 5	1		JMAX	Number of rows in grid. (Must be at least 3.)

*The input variables are described in more detail in Chapter VII. Instructions for restarting a calculation are given in Section 7.3.

(Numbers in Parentheses are Non-zero Default Values)

1	2 3 4 5 6	7	8 9 10 11 12 13 14 15 16		
2	42	1		MAPS	When MAPS=1, a symbolic map for <u>compression</u> is printed on EDIT prints. When MAPS=2, a symbolic map for <u>density</u> is printed on EDIT prints. When MAPS=0, maps are not printed.
2	43	1		NUMSCA	Number of times print frequency is rescaled.
	44	1		PRLIM	Time or cycle to change print frequency.
	45	1		PRDELT	Time (secs.) between EDIT prints when printing on time.
	46	1		PRFACT	Factor by which print frequency is increased.
2	47	1		I1	Number of columns with non-zero energy+2. ($I1 \leq IMAX$)
2	48	1		I2	Number of rows with non-zero energy+2. ($I2 \leq JMAX$)
2	49	1		IPCYCL	Number of cycles between EDIT prints when printing on cycles.
2	56	1		IPLGRT	The right-most column of the plugging region of the target.
	59	1		PLWMIN	The specific plastic work criterion for extending the plug. (ergs/g)
2	60	1		IPLGBT	The bottom row of the plugging region of the target.
2	61	1		IPLGTP	The top row of the plugging region of the target.
	62	1		GAMMA	"γ" in $P=(\gamma-1)\rho E$ for material #20, an ideal gas.

(Numbers in Parentheses are Non-zero Default Values)

1	2 3 4 5 6	7	8 9 10 11 12 13 14 15 16		
2	6 8	1		NMAT (1)	Number of material packages, excluding the void package.
	6 9	1		CYCMX	Number of passes through INFACE. (2.)
	7 0	1		CYCPH3	Number of passes through SPHASE. For a pure hydro calculation, set CYCPH3=-1. (1.)
2	7 2	1		NTRACR	The number of material tracers per cell diagonal to be maintained by ADDTCR. (See NADD)
2	7 3	1		NMXCLS (2)	Maximum number of interface cells in grid on any one cycle.
2	7 8	1		NTPMX (3)	Maximum number of material tracers <u>per package</u> to be generated by TSETUP or ADDTCR.
2	8 1	1		NTCC (4)	Maximum number of passive tracers to be generated.
	8 2	1		SIEMIN	If change in specific internal energy of a cell due to transport is less than SIEMIN, the change is ignored. (10^5)
	8 5	1		EMIN	Minimum specific internal energy used to compute the pressure of material #20, an ideal gas. (10^7)
	8 6	1		PMIN	Minimum non-zero pressure. If $\|P(k)\|<PMIN$, $P(k)=0$. (5×10^6)

(1) See first dimension of XMASS array.
(2) See second dimension of XMASS array.
(3) See second dimension of TX array.
(4) See dimension of XP array.

1	2 3 4 5 6	7	8 9 10 11 12 13 14 15 16		(Numbers in Parentheses are Non-zero Default Values)
2	8 7	1		INTER	When non-zero, INTER generates certain diagnostic prints. (See Section 9.2)
	9 5	1		REZ	When REZ=1.0 on a restart cycle, the grid is rezoned. (See Section 8.1 and IEXTX, JEXTY)
2	9 6	1		NODUMP	When NODUMP=1, EDIT does not write any restart dumps.
2	1 0 5	1		NLINER	The package number of the liner material that forms the jet. Define only when calculating the collapse of a shaped charge liner.
2	1 0 9	1		NVRTEX	The second index of the void tracer that is at the vertex of the void closing region. Define only if using the automatic void closing routine, VDCLOS.
	1 1 0	1		ROFPS	Round-off epsilon. (10^{-5})
	1 1 1	1		PLGOPT	PLGOPT must be set to 1.0 to generate a plugging calculation.
2	1 1 2	1		NSLD(5)	Maximum number of slipline cells in grid during any one cycle.
	1 1 3	1		FINAL	Final value of stability fraction. (.4)
2	1 1 5	1		NOSLIP	NOSLIP should be set to 1 when sliplines are <u>not</u> used.
2	1 1 6	1		LVISC	When LVISC=1 an artificial viscosity is added to cell boundary pressures in HPHASE.

(5) See dimension of MSLD array.

(Numbers in Parentheses are Non-zero Default Values)

1	2 3 4 5 6	7	8 9 10 11 12 13 14 15 16		
2	118	1		NADD	Every cycle that is a multiple of NADD, ADDTCR checks the spacing of the material tracers in the region specified by MINX, MAXX, MINY, MAXY. (Define NTRACR also.)
2	119	1		MINX	Leftmost column of region in which tracers will be added.
2	120	1		MAXX	Rightmost column of region in which tracers will be added.
2	121	1		MINY	Bottom row of region in which tracers will be added.
2	122	1		MAXY	Top row of region in which tracers will be added.
2	123	1		IEXTX	If IEXTX=1, the grid will be rezoned in the X-direction.
2	124	1		JEXTY	If JEXTY=1, the grid will be rezoned in the Y-direction.
	139	1		STAB	<u>Initial</u> value of stability fraction. (10^{-3})
	144	1		DTMIN	Minimum allowable value of time step. If DT<DTMIN, the calculation stops. (10^{-11})
	148	1		CRATIO	The minimum compression ratio of adjacent cells that will trigger compression-weighting of pressures and velocities in HPHASE; (See Section 2.2.2.4) (10^{4})
	149	1		BBAR	Constant in approximation of local sound speed: $C=C_o+BBAR\cdot\sqrt{P}$. Used to determine Δt. (.5)
1	50	1		TSTOP	Time (secs.) calculation will stop if stopping on time. (Must be included even when stopping on cycles in which case TSTOP=0.)

Before the dummy end card (Z(150)), insert the following sets of data cards, (The formats for these sets of cards are specified in the pages that follow.)

1. Cards defining cell dimensions.
2. Cards defining initial conditions of each material package.
3. Cards defining strength properties of each material package.
4. Cards defining material tracer particles of each material package and the void.
5. Cards defining slipline endpoints. If NOSLIP=1, these cards are omitted.
6. Cards defining HE initiation points. If no HE, insert <u>one</u> blank card.

CARDS DEFINING DX AND DY ARRAYS

Define DX first.
NNT(I) is the number of zones that have dimension TEMP (I).
Set NNT(I) = 999 after all DX are defined <u>and</u> after all DY are defined.

1-10		11-20			21-30	31-40	41-50	51-60	61-70 / 71-80
NNT(1)	NNT(2)	NNT(3)	NNT(4)		TEMP(1)	TEMP(2)	TEMP(3)	TEMP(4)	(4I4,4X,4E10.2)

CARDS DEFINING INITIAL CONDITIONS OF EACH MATERIAL PACKAGE

1-10		11-20	21-30	31-40	41-50	51-60	61-70	71-80
12345	67890	1234567890	1234567890	1234567890	1234567890	1234567890	1234567890	1234567890

MFLAG(2)

(I5) Card defining the MFLAG of cell $k = 2$.
MFLAG(2) = - 1 if cell $k = 2$ contains an interface.
MFLAG(2) = N if cell $k = 2$ is a pure cell in material package N.
MFLAG(2) = 0 if cell $k = 2$ is a pure void cell.

Cards defining initial ρ, u, v, E_I of each material package. One card for each material package.

Material Code #		Density	Specific Internal Energy	Radial Velocity	Axial Velocity	(I5, 5X. 4E10.2)

CARDS DEFINING STRENGTH PROPERTIES OF EACH MATERIAL PACKAGE

Yield strength of material = $(Y_o + Y_1\mu + Y_2\mu^2)(1 - \frac{E_I}{E_m})$.

If material has no tensile strength, set AMDM = 1.0.

If material is not to fail in tension, set AMDM = .001.

Include one card for each material package.

1-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80
1234567890	1234567890	1234567890	1234567890	1234567890	1234567890	1234567890	1234567890
Y_o	Y_1	Y_2	E_m	Rigidity Modulus G	Failure Threshold AMDM		

CARDS DEFINING TRACER PARTICLES OF EACH MATERIAL PACKAGE AND THE VOID

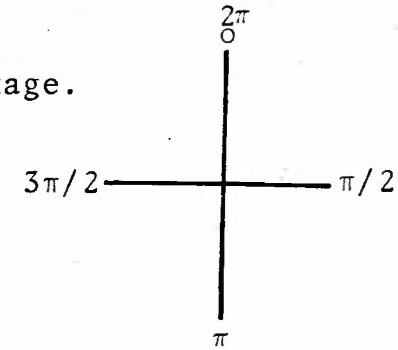
Repeat cards 1, 2 and (if required) 3 for each line segment or arc of each material and void package boundary (except package boundaries that are also grid boundaries).

Tracer particles for each package must be input in an order that will put the package to the left of any two consecutive particles. Refer to Section 7.2.5.

LTYPE = 1 straight horizontal line
2 straight vertical line
3 straight diagonal line
4 arc of circle
5 arc of ellipse

MPN = Material package number (void = NMAT + 1)

NPTS = Number of points to be placed along line or arc.



LTYPE must be negative on last segment of a package or subpackage.
LTYPE = 100 after all boundaries of all packages are defined.

Card	1-5	6-10	11-20	21-30	31-40	41-80
1	LTYPE	MPN	NPTS			(3I5)
2	starting x-coordinate		starting y-coordinate	final x-coordinate	final y-coordinate	For line segment (cm) (4E10.4)
2	Starting Angle of Arc		Terminal Angle of Arc			For arc of circle or ellipse (radians) (2E10.4)
3	x-coordinate of center of circle		y-coordinate of center of circle	Radius of circle		For arc of circle (cm) (3E10.4)
3	A		B	XC	YC	For arc of ellipse (cm) (4E10.4) $\left[\frac{(X-XC)^2}{A^2}+\frac{(Y-YC)^2}{B^2}=1\right]$

(Form for tracer particle definitions)

1-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80
1 2 3 4 5 6 7 8 9 0	1 2 3 4 5 6 7 8 9 0	1 2 3 4 5 6 7 8 9 0	1 2 3 4 5 6 7 8 9 0	1 2 3 4 5 6 7 8 9 0	1 2 3 4 5 6 7 8 9 0	1 2 3 4 5 6 7 8 9 0	1 2 3 4 5 6 7 8 9 0

CARDS DEFINING SLIPLINE ENDPOINTS

Omit these cards if NOSLIP = 1 (sliplines are not being used).

One card for each material package.

1-10		11-20		21-30		31-40	41-50	51-60	61-70	71-80
MASTRD	NSLAVD	NBGMD	NBGSD	NENDMD	NENDSD	(6I5)				

MASTRD = N if package N is a master package
= 0 otherwise

NSLAVD = N if package N is a slave package
= 0 otherwise

NBGMD = First tracer of package N that will define the slipline if package N is a master package
= 0 otherwise

NBGSD = First tracer of package N that will define the slipline if package N is a slave package
= 0 otherwise

NENDMD = Last tracer of package N that will define the slipline if package N is a master package
= 0 otherwise

NENDSD = Last tracer of package N that will define the slipline if package N is a slave package
= 0 otherwise

CARDS DEFINING INITIATION POINTS OF HIGH EXPLOSIVES

The initiation points must be input in ascending order of probable detonation time. Insert one blank card if calculation does not involve detonation of a high explosive.

IDET = 1 for primary initiation point
IDET = 2 for secondary initiation point
IDET = 0 end of initiation point data

1-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80
1234567890	1234567890	1234567890	1234567890	1234567890	1234567890	1234567890	1234567890
IDET	Material Package Number of HE	x-coordinate of Initiation Pt. (cm)	y-coordinate of Initiation Pt. (cm)	Time Delay (if any) (secs)	(2I10, 3E10.2)		

CARDS DEFINING AREA OF INITIATION FOR EACH INITIATION POINT

Specify areas in same order as points are specified above.

1-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80
1234567890	1234567890	1234567890	1234567890	1234567890	1234567890	1234567890	1234567890
Left x-coordinate (cm)	Bottom y-coordinate (cm)	Right x-coordinate (cm)	Top y-coordinate (cm)	(4E10.2)			

1	2 3 4 5 6	7	8 9 10 11 12 13 14 15 16		
1	1 5 0	1	0 .		Dummy end of generation deck.

APPENDIX C

SEGMENTING THE HELP CODE

The user of the HELP code has several alternatives in configuring the code on the computer, ranging from having all the subroutines loaded into core at once, which decreases execution time but requires more core storage, to varying degrees of segmentation, which decrease the core storage requirements but increase execution time because of the extra time required to transfer the various segments in and out of core. The segmentation discussed here and represented schematically in Figure C.1 attempts to minimize the storage requirements, yet hold execution time down by minimizing the number of times per cycle the computer must roll segments in and out of core.

In the figure, the subroutines in the first column, which is labeled LEVEL 1, are loaded into core and remain in core for the duration of the calculation. The blocks of subroutines, or segments, under LEVEL 2 and LEVEL 3 are then rolled in and out of core as needed by the various stages of the computational cycle. The INPUT-GENERATOR segment is executed only once per run, either in generating or restarting a calculation. If the user is not performing a plugging calculation, the REZONE-PLUG block is executed only when the grid is rezoned, a relatively infrequent occurence. Thus in most of the cycles only four LEVEL 2 segments (the CDT-EDIT segment, the HPHASE-SPHASE segment, the INFACE segment, and the TPHASE segment) and two LEVEL 3 segments are rolled in and out of core.

This configuration of the HELP code, and the associated systems routines, requires approximately 11,000 words of core storage for the instruction bank when executed on a UNIVAC 1108. The amount of storage required for the data bank is, of course highly dependent on the values of the parameters discussed in Appendix A.

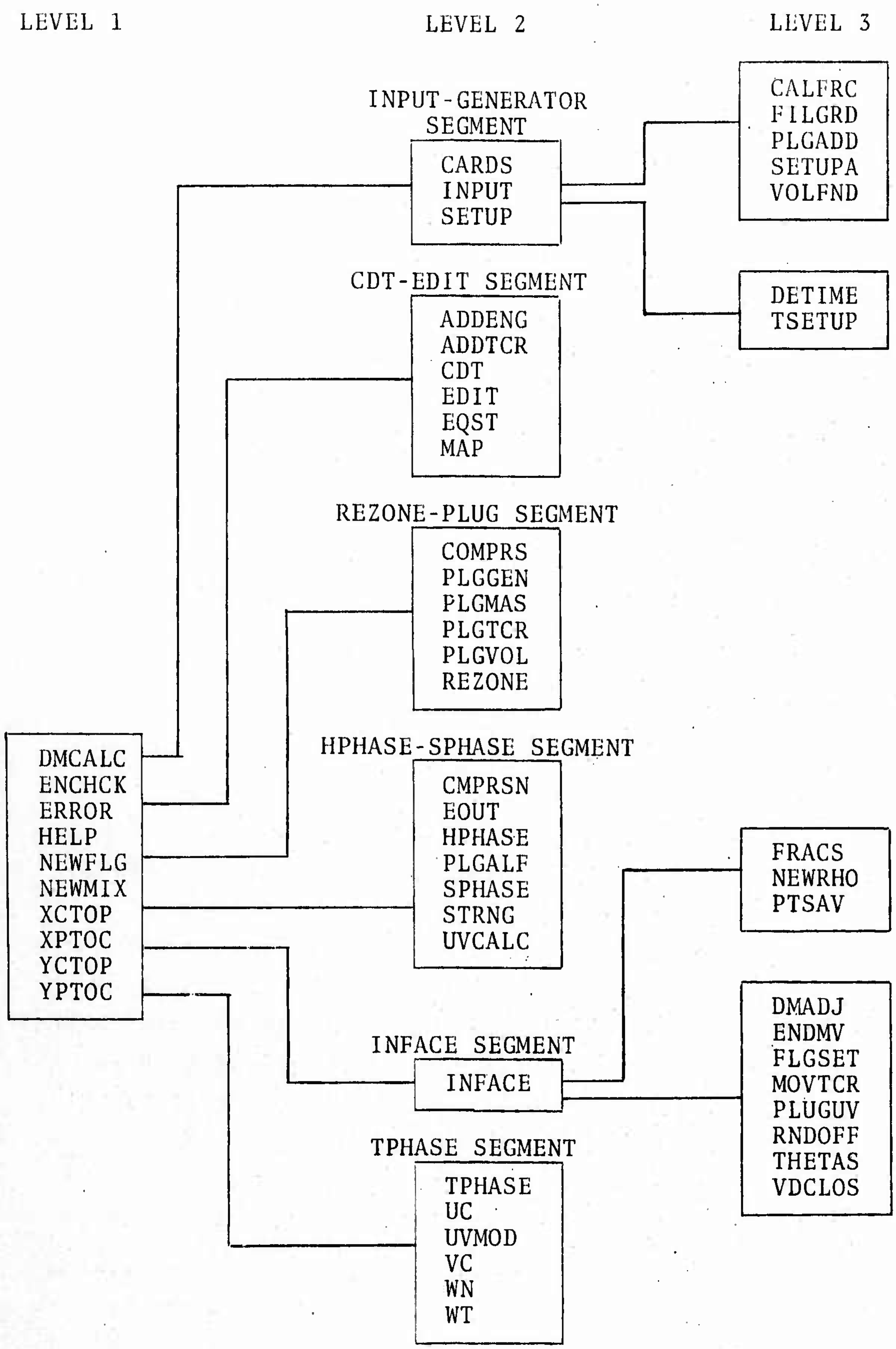


Figure C.1. A schematic representation of a method of segmenting the HELP code which is efficient both in terms of execution time and the computer core requirements.

INITIAL DISTRIBUTION

USAF/SAMI	1
AFSC/DLCAW	1
AFIT/LD	1
ASD/ENFEA	1
TAC/DRA	1
CIA, CRE/ADD/Publications	2
AUL/AUL-LSE-70-239	1
Redstone Sci Info Cntr, Ch, Doc Sec	2
USA Wpns Comd/SAPRI-LW-A	1
Picatinny Arsenal/SARPA-TS, Bldg 59	1
USN Nav Ord Lab/Tech Lib	2
Nav Ord Stn/Tech Lib	1
Nav Sys Cntr, New Port Lab/Tech Lib	1
USN WEA Cntr/Code 533	2
AFWL/Tech Lib	1
Ofc Nav Research/Code 473	1
DDC	2
US Atomic Energy Com/Lib Rm G-042	1
Nav Research Lab/Code 2627	1
ASD/ENESS/S. Johns	1
AFIS/INTA	1
TAWC/TRADOCLO	1
AFATL/DL	1
AFATL/DLOSL	9
AFATL/DLDG	1
Systems, Science & Software	10
AFML/MAMD	1
Georgia Inst of Tech	2
Lehigh University	1
Univ of Florida	2
AFATL/DLJW	10
AF Ofc of Sci Rsch, Aeromech Div	2
AEDC/ARO, Inc, Lib/DLCS	1
USAFE/DOQ	1
PACAF/DOO	1

(The reverse of this page is blank)